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DISTRIBUTION OF SCIENTIFIC MAN-POWER

FROM the national point of view, a proper balance must be struck between productive effort and research effort, as in any successful private business; it is the task of management to secure that the appropriate balance is achieved, and that it is achieved without diverting too many creative and fertile minds to the equally essential task of administration. This is the point of view from which the present organisation of scientific and industrial research in Great Britain must be considered. As Sir John Anderson rightly said in his lecture to the Society of Chemical Industry when he received the Messel Medal on July 14, Great Britain has been a pioneer among the nations in the organisation of scientific research; but nevertheless we must have the organisation of science in the public service constantly under review. In particular, it is essential that we should consider whether, by any changes in the existing organisation or by more careful use of our limited scientific man-power, we can rectify admitted weaknesses in the development of research results, and in the supply of trained scientific men and technologists.

It seems clear from its first report that the Advisory Council on Scientific Policy is concerning itself with this broad question; but it is equally important that the scientific and industrial world should be provided with adequate data on which to base a sound and independent judgment of the correctness of Government organisation and policy. That is the fundamental reason why early resumption of the publication of full reports from the Department of Scientific and Industrial Research is so important. Moreover, since a sound judgment cannot reasonably be made on the results of any one year, it is the more important that there should be available as early as possible a full account of the war effort, and especially before the Department is irretrievably committed to any schemes of expansion which involve large drains on man-power or equipment.

Admirably as the recent report from the Chemistry Research Board (see p. 228 of this issue) fills the need from one point of view—and there can be nothing but praise for much of the work done and also for the special attention being given to the development of new techniques for the benefit of both industry and science—a striking feature of the report illustrates the necessity for completing the picture. This is the way in which the work of the Chemical Research Laboratory is linked up with that of other Government institutions and departments. The Corrosion of Metals Section, for example, has collaborated with the Light Division of the National Physical Laboratory and with the British Iron and Steel Research Association, as well as with the Water Pollution Research Laboratory, the British Cast Iron Research Association and the British Non-Ferrous Metals Research Association, and has carried out work for the Ministry of Supply and the Ministry of Works. The High Polymers and Plastics Section has worked

with the Engineering Division of the National Physical Laboratory and the Forests Products Research Laboratory, and the Coal Tar Section with the Heat Section of the Physics Division and the Metrology Division of the National Physical Laboratory. The Chemistry Research Board itself directs attention to contacts maintained with other departments and to field trials by the Colonial Office on the control of nagana in Africa by the use of phenanthridinium compounds prepared in the Laboratory, as well as the development of the production of food yeast in Jamaica.

There can be no question as to the value of such collaboration in achieving economy of effort and equipment, and whatever doubts are entertained as to the value of the research association movement, there are *a priori* reasons for believing that the work of such institutions as the Chemical Research Laboratory is thoroughly sound, and that under the Chemistry Research Board it is making an important, and possibly a vital, contribution to the advancement of science and to industrial development, apart from the study of the specific scientific problems which arise in the public service. The very way in which it is interlocked with the work of other bodies, however, makes it important that we should consider the Government organisation of research as a whole. Otherwise there is danger that justifiable expansion at one point may have serious and undesirable repercussions on activities elsewhere which it is vital to maintain or even expand.

It was noticeable that, in his address at Edinburgh, Sir John Anderson was purely descriptive and neither commended nor condemned what he described, though those who followed his survey closely might perhaps have gained from his inflexions some idea of the general trend of Sir John's own mind. Neither can it be said that the Advisory Council on Scientific Policy has in its first report addressed itself to the broadest aspects of the question. The Council was asked by the Government to make recommendations on the specific questions, *inter alia*, of the appropriate organisation for scientific research within the Government, with special reference to research on building and on fuel and power, and the appropriate form of research effort to assist the maximum increase in national productivity during the coming decade. In regard to the former of these problems, the Advisory Council was asked to consider, in particular, what should be the respective functions of Government departments, of the research councils and of outside bodies (including the boards of socialized industries) in carrying out research.

The Advisory Council recognizes that on one hand research of the highest quality depends on a freedom which is difficult to reconcile with the normal conditions of Government work, and on the other hand, that close contact between the research worker and the user of the results of applied research is essential in order that the results obtained may be of practical value and supply data and a satisfactory foundation for the research itself. It therefore devoted considerable time at the outset to discussion of the general principles which should apply to the organisation of Government research and its application, and as a result reached agreement on two general principles. First, the executive department should be responsible for identifying problems requiring research, settling their order of priority, deciding where the various investigations should be carried out and applying their results. Secondly, the research councils, and particularly the various branches of the Department of Scientific and Industrial Research, should continue to be free to initiate background research where they think fit, free from administrative control of the executive departments and consequently from considerations of day-to-day expediency.

Like Sir John Anderson in his lecture, the Advisory Council rejects the idea of a Ministry of Science and agrees that no attempt should be made to concentrate responsibility for carrying out all Government scientific research on the Lord President of the Council. It considers that this would intensify rather than diminish the old cleavage between science, administration and policy; although the Lord President should assume a particular concern for such branches of scientific research as have a wider application than to the problems of a particular department.

While there will probably be much general support for these views, it will be noted that the Advisory Council does not discuss in the present report the effectiveness or adequacy of the general structure, or whether its disposition as between Government and industry could be improved with advantage to the public welfare. This is the more important in view of the next conclusion, that if the executive departments are to discharge their considerable scientific and technical responsibilities thus defined, they will require to employ considerable scientific staffs, corresponding to the operational research units attached to the Service Ministries and Commands during the War. The appointment of a 'chief scientific officer' by the departments, provided with an adequate staff, however admirable in principle, may well be open to question on practical grounds at the present juncture. Can we really afford to withdraw such men from production while we are still awaiting the increase in scientific and technological man-power recommended by the Barlow Report?

The recommendation, it is true, is in line with the observations in the report of the Select Committee on Estimates, which in its third report for the Session 1946–47, dealing with expenditure on research and development, referred to the absence of sufficient provision for the identification of scientific problems in day-to-day administration as one of the greatest weaknesses in the Government organisation. The Select Committee itself recommended the appointment in all executive departments of scientific advisers who should have a high standing and direct access to the policy-forming level. There can only be welcome for any proposal which will give the scientific man more influence in guiding the formulation as well as the administration of policy, and for the recommendation that executive departments to the work of which science can contribute should assume a more positive role than hitherto in the organisation

and direction of research required for their own purposes and in supervising the application of its results. Nevertheless, however urgent and essential may be the appointment of chief scientific officers for the planning of the present Government research programme in the best way to meet national needs, the question must still be asked where the men are to be found, and whether there are not other activities which could be curtailed or discontinued to release men for such work.

These recommendations were submitted by the Advisory Council in a general report on May 22, 1947, and two such appointments have since been made, to the Ministry of Food and to the Home Office respectively. The same principles have been applied to the Council's consideration of the special requirements of building research. Here it recommends that the Department of Scientific and Industrial Research should retain full responsibility for scientific research and initial development in building, as well as its freedom to initiate research and undertake investigations at the direct proposal of the building industry. The Ministry of Works should retain the broad responsibilities indicated for executive departments in general, including that of keeping the technical development of the building industry under review, promoting the final stages of development, and encouraging the use by industry of the results of research. For the discharge of these scientific functions the Advisory Council recommends, in addition to the appointment of a 'chief scientific officer', a scientific advisory council of scientific men and representatives of the building industry in equal proportions, and such a Council on Building and Civil Engineering and Development was established on December 8, 1947. Under these proposals, the responsibility for identifying the problems requiring research and determining their priority, as well as for initiating research in the sociological or economic field, rests with the Ministry of Works. In like manner the Advisory Council recommended that the scientific and engineering staff of the Ministry of Fuel and Power should be substantially strengthened, and that a 'chief scientific officer' should be appointed with adequate status and with responsibility for making a broad strategic survey of the problems on which to base a general research problem for the fuel and power industries. He would be assisted by an advisory council including not only scientific men but also economists, administrators and men of wide practical experience in the nationalized industries. The Advisory Council has rejected a suggestion to transfer the Fuel Research Station to the Ministry of Fuel and Power; but advised that the Station should continue to act as an agent in carrying out such research as the Ministry may decide to allocate to it.

There can be no doubt that, under its terms of reference, the Advisory Council on Scientific Policy is discharging important functions not hitherto provided for, and its first report encourages the hope that the Council will go much more closely into such important questions as the appropriate pattern for the scientific organisation of Government departments in general as well as that of the general structure of the organisation of scientific and industrial research in Britain, the principles on which research in the nationalized industries should be organised and the overall requirements of scientific man-power and the appropriate measures for its recruitment and training. Meanwhile, its report should reassure those who fear that the conduct of scientific research by Government departments or the research councils will be overplanned. Its pronouncements on the status of 'chief scientific officers' will be welcomed by those who have urged, as has been done in these columns for many years, that the scientific man should be given the status which will enable him to make his voice heard effectively in the determination of policy where scientific factors are involved; and that the possession of scientific qualifications should not constitute a bar to advancement to positions of the highest administrative responsibility when the requisite administrative talent is joined to such qualifications.

Nevertheless, the report will inevitably cause some misgivings. As is rightly emphasized, to meet the urgent requirements of the economic situation the direction in which scientific research and development should be promoted cannot be determined solely from the point of view of science itself; and its gravity makes it essential to develop quicker and more efficient application of the results of fundamental research, demanding in turn an efficient scientific organisation in executive departments and a better supply of the type of technologist who can effectively apply the results of fundamental research. It is no easy task to strike the right balance between long-term and short-term interests, between the needs of academic and industrial research, between the requirements of science and Government; and however valuable the Advisory Council may prove in future in deciding such issues in terms of an overall scientific and economic policy, the present report will not satisfy those who believe that an excessive proportion of the general as well as the scientific man-power of Britain is being diverted from productive to non-productive occupations.

This is not to suggest that research is non-productive; but as we have already stressed, if too large a proportion of scientific workers is employed on research or the dissemination of its results, there will not be enough available to apply those results. The Advisory Council does not entirely ignore this question of production; but the special Committee on Research and Productivity appointed by the Advisory Council, with Sir Claud Gibb as chairman, and the functions of which have now been transferred to a new and independent Committee on Industrial Productivity, was concerned more especially with the human factor in production, and such matters as nutrition and production and the improvement of technical information services. The fundamental question of the proper distribution of the scientific man-power of Britain between defence and civil requirements is only touched upon in that part of the Advisory Council's report which deals with scientific man-power, and even here the vital issue of the distribution between productive industry and

other civil requirements, including services of all kinds, is not adequately examined. This, however, is really the most important section of the Advisory Council's report, and requires fuller discussion in the light of the revised estimates of university expansion and the prospective demand for scientific man-power which have appeared since the Barlow Committee reported in 1946.

CHEMICAL SYNTHESIS MADE EASY

Synthetic Methods of Organic Chemistry

A Thesaurus. By W. Theilheimer. Vol. 1: 1942–1944. Translated from the German by Hans Wynberg. Pp. x + 254. (New York and London: Interscience Publishers, Inc., 1948.) 30*s*.

THIS is a new type of organic chemical publication. The volume under review is a translation of a German version published in Basle in 1946, and purports to cover the original literature of the period 1942–44. In fact, references to earlier publications are frequently given. Volume 2, covering the literature of 1945–46, has now been published in German, and presumably an English translation of this will appear in due course. If there is to be a series of volumes appearing at two-year intervals, then steps should be taken to reduce this time-lag between publication of the original Swiss edition and the appearance of its translation. The work is described as a "Thesaurus", a word which is defined by the Shorter Oxford English Dictionary as meaning a 'treasury' or 'storehouse' of knowledge. This savours somewhat of grandiosity, and it remains to be seen whether organic chemists will regard the work so highly as the description implies. For the present, they will be content to accept the commendation of Prof. Reichstein in the foreword which he contributes, and to give the volume a conspicuous place on their shelves of reference works.

The author's intentions are admirable. The present volume summarizes more than seven hundred reactions, with literature references, and the information collected will be of value not only to those who are interested in synthetic methods but also to those who have a general interest in organic reactions and their current applications. As Prof. Reichstein points out in his foreword, the actual methods of organic chemistry are not classified and recorded in such a highly systematic way as are new compounds. Until recently the best available reference book for methods was "Houben", which is now a little out of date, and although there are excellent newer books on methods, such as "Organic Reactions" and "Newer Methods of Preparative Organic Chemistry", these deal only with reactions in strictly circumscribed fields.

Dr. Theilheimer has attempted to give a systematic survey of reactions likely to be of value in organic synthesis. This has of necessity meant making a selection, based on personal preference. The supreme difficulty of the project has been to devise a system of classification sufficiently simple to enable the entries relating to the desired reactions to be found readily; and sufficiently elastic to allow for an increase in the range of reactions to be included in future volumes. To meet this difficulty the author has devised a new form of symbolism, based on the system of classification used by C. Weygand in his "Organisch-chemische Experimentierkunst" (also available in an English translation). Probably familiarity with the system will enable the user to find at once the references to the reaction in which he is interested; but until he has acquired this familiarity the novice will be inclined to flounder rather helplessly, and will probably tend to rely on the index which, although good, is by no means perfect. It would have been of assistance if a table of contents could have been included, with page numbers of the main headings, such as "Formation of C–C Bond".

For the most part, the methods enumerated do not appear to be new, but are examples of reactions already known, taken from the literature of the period under review. It is doubtful whether the ideal system of classification has been found. The system used results: (*a*) in the grouping together of reactions which have very little in common except the nature of the linkage which appears in the product, and (*b*) in the wide dispersal of very similar reactions. As an example of the latter we find that reactions numbered 652 and 768 are of precisely the same type, namely, union of aromatic nuclei by elimination of hydrogen halide by means of potassium hydroxide. There are some inconsistencies. Aromatic rings are sometimes shown with Kekulé double bonds and sometimes not; it is curious to find potassium alcoholate listed in one place as a reagent for the preparation of α-*iso*nitrosoketones and in another place sodium nitrite. Also, it is a little odd to find acetic acid and sulphuric acid among the reagents used for nitration. The formulæ appear to have been transcribed exactly from the Swiss edition, even to the errors which have been detected in the formulæ given under numbers 192 and 695. In some cases translation has been accompanied by the appearance of new errors. Thus, in section No. 147 the name of an author is spelt incorrectly and in section No. 152 2-acetylfluorene is erroneously given as 8-acetylfluorene. These, however, are minor matters, and the author is to be congratulated on a courageous attempt to fill a serious gap in the literature of organic chemistry.

J. W. COOK

BIOLOGICAL STANDARDIZATION OF VITAMINS

The Biological Standardisation of the Vitamins

By Dr. Katharine H. Coward. Second edition. Pp. vii + 224. (London: Baillière, Tindall and Cox, 1947.) 16*s*. net.

SINCE the early 1930's, Dr. Katharine Coward has worked untiringly to popularize sound methods of biological standardization of vitamins. The first edition of her book appeared in 1938. In bringing out the second she has the satisfaction of preaching to the almost converted. The last ten years have seen no spectacular change in the principles of biological assay of vitamins, but much refinement of technique and broadening of scope. Dr. Coward has catered for both, but has followed her original plan of discussing only those tests of which she has personal experience and only those vitamins for which international standards are available. This strictly orthodox approach is perhaps too harshly restrictive; of the whole gamut of the B vitamins now known in the pure form, vitamin B_1 is the only one considered; a mention of riboflavin, pyridoxin and pantothenic acid, for which reliable tests are available, would certainly have been useful.

The presentation of the statistical methods has been considerably revised and improved. The treatment is very sound and comprehensive, though perhaps, for a beginner, some parts are too condensed, and scarcely enough stress is laid on criteria of significance.

Dr. Coward might well consider amplifying some of these useful statistical chapters; she could gain space for it by cutting out unnecessary repetition in the description of biological technique. To quote only one example of redundancy, the formula of one salt mixture is given in full no less than three times, on pp. 32, 135 and 155.

Most misprints of the first edition have been corrected; but by a strange fluke 'ingestation' has again escaped unscathed, to appear repeatedly on pp. 17–19.

In too many branches of science the standard monograph is a dry-as-dust compilation by scissors and paste. Vitamin workers in the field of biological standardization are fortunate to have in Dr. Coward a mentor who knows and loves the land through which she guides them. We wish her well in the task of charting for her third edition the discoveries of the next ten years.

S. K. Kon
P. White

VEGETATION OF THE ARGENTINE

La vegetación de la Argentina

By Profs. L. Hauman, A. Burkart, L. R. Parodi, and A. L. Cabrera. (Geografía de la República Argentina. Vol. 8.) Pp. 350. (Buenos Aires: Gaea, Sociedad Argentina de Estudios Geográficos, 1947.)

UP to the present, the botanist or agriculturist desiring information on the plant cover of the Argentine has been obliged to seek it among a large number of scattered publications, some in rather obscure periodicals, many out of print. Assistance has been given in recent years by Castellanos and Perez-Moreau's valuable classified bibliography of South American botany, published in *Lilloa*, volumes 6 and 7, 1941, and by the reprinting of some of the older works, such as, for example, Hieronymus' "Observations on the Vegetation of the Province of Tucumán", 1874, republished in 1945 by the University of Tucumán; but no compact account of the plant resources of this extremely varied country has yet been available. The appearance of the volume now published by the Argentine Society of Geographical Studies and written by botanists of authoritative position is, therefore, much to be welcomed. It is concise and so far as possible complete, although as Cabrera, writing of the Patagonian shrub steppe, notes, there is still much room for botanical and sociological investigation. The material was ready for publication in 1939; but printing had to be deferred until 1947.

The work has a geographical bias, and the subject-matter is arranged in accordance with the natural regions into which the Argentine is divisible. These are mapped by Parodi. Hauman, the senior author, has written the introduction and the sections which deal with the forests of Misiones and those of the 700-km. long narrow strip running from north to south through the provinces of Salta, Jujuy and Tucumán; with the Gran Chaco; with the enormous scrub or thorn woodland area known as the *Monte*; and with the sub-Antarctic forests and the Andean regions. Burkart describes the Mesopotamian region lying between the Rivers Paraná and Uruguay, in which forest alternates with savannah, the latter predominating. L. R. Parodi contributes the account of the great grass steppe of the pampas, and A. L. Cabrera that of the Patagonian shrub steppe.

The reader is impressed by the wealth of plant resources of the Argentine and by the great diversity of the material described. The influence of cultivation and stock-raising is perceptible principally in the pampas, not always to the detriment of the plant cover. Where, however, the exploitation of light lands in dry, wind-swept areas is excessive or even is practised at all, there is grave risk of wind erosion. This is so in a very large part of the middle west, where shifting sand dunes 30–40 m. in height, practically denuded of all vegetation, are to be seen.

G. M. Roseveare

GUSTAV FECHNER

Religion of a Scientist

Selections from Gustav Th. Fechner. Edited and translated by Walter Lowrie. Pp. 281. (London: Kegan Paul and Co., Ltd.; New York: Pantheon Books, Inc., 1946.) 17*s.* 6*d.* net.

DR. LOWRIE'S biography of Fechner and selections from his writings make an interesting book. Fechner was a remarkable and most unusual kind of man, as unlike the standard nineteenth-century German professor as can be imagined; a poet, humorist and above all a Romantic. He is remembered chiefly in connexion with the Weber–Fechner law. His work was certainly a landmark in the study of sensory response. But the range of validity of the Fechner law is restricted; it states the value of a ratio between two physical quantities (total stimulus and least discernible increment), and what it signifies psychologically is doubtful. The assertion on the dust cover of this book, that through Fechner "psychology developed into an 'exact' science susceptible of mathematical treatment", is, to put it mildly, misleading. Dr. Lowrie himself says nothing of the sort.

There is a legend that Fechner was a physicist who was afflicted in middle life by an illness which affected his sight and probably his reason, and he thereafter gave up science and took to religious mysticism. Dr. Lowrie's narrative explodes the legend. Fechner's best-known religious work, "Life after Death", was published four years before his illness, and the work on Fechner's law was done several years after. All his life he found the mechanistic view of physical science intellectually stifling, and fought against it; first with parodies and jokes, afterwards more seriously and constructively. He took a pan-psychic or pan-theistic view of the natural world rather characteristic of the Romantics of his period. Unlike most of them, however, he did not turn his back on science; instead he tried to enlarge the scientific insight.

Fechner was rash in speculation and perhaps entirely mistaken in thinking that scientific thought could transcend its traditional limits. The mistake was not that of a man who is just stupid or ill-informed. The illness he had still remains mysterious, but does seem to have originated in mental conflict of some kind. Physiologists should note the strange diet of raw lean ham soaked in wine and lemon juice which initiated Fechner's recovery from his digestive troubles (p. 38).

A. D. R.

PHYSICAL AND CHEMICAL ASPECTS OF RUBBER TECHNOLOGY

THE Rubber Technology Conference, held in London during June 23–25 under the auspices of the Institution of the Rubber Industry, provided the first opportunity since the War for scientific workers and technologists in this field from many countries to meet for a general discussion of their problems. The papers presented covered a very wide range of subjects, from purely scientific to highly technical; this short article is an attempt to review only the more scientific aspects of the matters discussed.

Physical Aspects

It has been known for a long time that natural rubber crystallizes on stretching, and it is generally supposed that this phenomenon has an important bearing on such mechanical properties as tensile strength and resistance to tearing. In a paper on the degree of crystallization in natural rubber, Dr. J. M. Goppel discussed his recent X-ray studies of the absolute amount of crystallization as a function of the degree of extension of the rubber. For a highly extended vulcanized rubber, the fraction of crystalline material was found to be only 29 per cent, which is very much lower than figures given by the earlier work of Field (60–80 per cent). Correspondingly low figures were obtained for frozen raw rubber (unstretched), for which the degree of crystallization was found to increase with time of storage. The highest figure obtained was 38 per cent for crepe rubber which had been stored for twenty-nine years. It was shown also that estimates of crystallinity from density changes reported in the literature led to values of the same general magnitude.

Papers dealing with the design of engineering components in rubber were contributed by Mr. R. S. Rivlin, who dealt with the theoretical basis of this subject, and by Mr. H. L. Jenkins and Mr. H. D. Cooper, whose approach was from the experimental side. Mr. Rivlin referred to the inherent limitations of the classical theory of elasticity—particularly the restriction to small deformations—and gave an outline of recent developments in the theory of large elastic deformations, with particular reference to incompressible materials, that is, materials like rubber, the volume of which is substantially constant on deformation. Rivlin's theory is centred on the existence of a unique work of deformation or stored-energy function corresponding to a specified state of strain; from this stored-energy function the generalized stress-strain relations are readily derived. The theory has been applied to a number of problems of practical interest, among which shear mountings and torsional couplings were particularly considered.

From experiments on the axial compression of cylindrical blocks between lubricated plates (to allow free lateral expansion), Mr. Jenkins and Mr. Cooper showed that the properties of rubber in compression can be adequately represented by the formula derived from the statistical theory of James and Guth. This formula, which had previously been applied mainly to rubber in tension, involves only one physical constant k, which is analogous to the modulus of rigidity in the classical theory. The experimental values of k are nearly independent of the ratio of length to diameter of the cylinder. In the case of shear, the theoretical linear relation between stress and strain was found to be inadequate; but the experimental results can be represented by the use of the same constant k, together with an empirical 'shape function'. It was pointed out, however, that the values of k are dependent on the time of loading or 'load history' adopted, and a machine was described which has been designed to facilitate the application of different load-history patterns.

Another aspect of the mechanical properties of rubber, the rate of retraction from the stretched state after release of the tension, was examined by Dr. B. B. S. T. Boonstra. The technique employed depends on the breaking of electrical contacts by the motion of the rubber, the time between successive breaks being measured by the fall in potential of a condenser discharging through a resistance. Differences were found both in the rates of retraction, and in the residual temporary 'set', between the various rubbers (natural and synthetic) examined. The speed of retraction did not appear to be correlated with rebound resilience; for example, butyl rubber, though showing very low rebound resilience, gave a retraction-rate only slightly below that for natural rubber.

The two sessions devoted to the discussion of compounding ingredients included a number of papers dealing with the effects of fillers, particularly carbon black, on the physical properties of rubber. Although carbon black is regarded as the outstanding 'reinforcing' filler for rubber, there appeared from the discussion to be no general agreement as to what constitutes reinforcement, though tensile strength, stiffness and abrasion resistance were the most frequently quoted criteria. In view of this lack of definition of the concept, it is not surprising to find that the mechanism of reinforcement is still but imperfectly understood. A new and interesting fundamental approach to this problem was provided by Dr. W. R. Smith and Mr. W. D. Schaeffer, who have attempted to evaluate the surface activity of various carbon blacks by measurements of the heats of adsorption of gaseous hydrocarbons. Their results reveal a marked variation in heats of adsorption with degree of surface covering (up to 1·5 molecular layers), which points to a selective adsorption at specially active sites. How far these conclusions are directly applicable to the carbon-rubber system has yet to be established; but the evidence suggests that there is a rather close correlation between the initial heats of adsorption and the reinforcing power of the black.

A general physical approach was adopted in the paper by Dr. E. Guth on the theory of filler reinforcement. Guth's theory concentrates attention on the effect of included rigid particles on the modulus of an elastic medium. This theory leads to an expression for the modulus in terms of the volume concentration of the filler which may be regarded formally as an extension of the well-known Einstein relation for the viscosity of a liquid medium containing solid particles in suspension. By means of this equation it should be possible to distinguish between approximately spherical particles, and particles possessing marked geometrical anisotropy. The experimental evidence quoted by Dr. Guth indicated that non-reinforcing fillers like calcium carbonate correspond to the case of spherical particles, while reinforcing fillers require the assumption of highly elongated particles. Since individual carbon particles are roughly spherical in shape, this is regarded as evidence for the formation of elongated chain-like agglomerates of particles, such

as have frequently been observed in the examination of blacks under the electron microscope. Indeed, by a suitable modification of the theory it is possible to include the effect of non-sphericity in terms of a 'shape factor'; the shape factors thus derived are found to agree reasonably well with the shapes observed in the electron microscope. This conclusion received further support from Dr. L. H. Cohan, who presented electron microscope evidence for the existence of chain-like structures, which appear to be of characteristic form for any particular mode of preparation of the black. A large number of measurements on a particular black yielded an axial ratio of 6, and this value was found to account for the observed increase of modulus, on Guth's theory, up to 25 per cent concentration.

This theory of reinforcement, as the subsequent discussion showed, is not without its difficulties. According to Dr. L. Mullins, the stiffening effect of carbon black 'wears off' after a small number of repetitions of the extension of the rubber, and gradually reappears on resting, suggesting a breakdown of the chain structures due to stressing. This aspect was further discussed by Mr. A. F. Blanchard and Dr. D. Parkinson, who made use of measurements of electrical conductivity, which is directly related to a net structure of the carbon particles, to throw light on the breakdown and re-formation of these structures. Their conclusion is that the degree of breakdown of structure on extension is relatively of a minor character, certainly not sufficient to account for the observed reduction of stiffness, which they attribute rather to the rupture of the bonds between the carbon particles and the rubber.

A contribution to the study of the optical properties of rubber was presented by Dr. L. A. Wood and Mr. L. W. Tilton, who described an accurate method of measuring refractive indices, in which the specimen was moulded into prismatic form between glass plates. Data were obtained at five different wave-lengths, and over a range of temperature, and compared with various theoretical formulæ for optical dispersion. An interesting result which emerged is the disparity between the isoprene unit and normal mono-olefins, which suggests that the middle C—C bond may partake of the properties of a double bond. A corresponding abnormality in bond-length was found from an X-ray analysis by Jeffrey of the closely comparable low-molecular crystalline compound, geranylamine hydrochloride.

The curious luminescence which may sometimes be observed on tearing rubber in a dark room was the subject of a paper contributed by Dr. A. van Rossem. From numerous experiments it has been shown that the emission of light is related to the type of filler with which the rubber is compounded. The effect was observed only in the presence of non-reinforcing fillers. The suggestion was made that the phenomenon is due to a discharge of electricity through the vacuoles which are known to be formed in such filled rubbers under tension.

On an entirely different subject, Prof. H. W. Melville and Mr. C. R. Masson reviewed recent techniques for the measurement of very small osmotic pressures, as encountered in the determination of molecular weights of high polymers. The difficulty of such measurements arises from the length of time required for the attainment of osmotic equilibrium. It was shown that this may be greatly reduced (*a*) by the use of bacterial cellulose as a semi-permeable membrane, and (*b*) by the use of a dynamic method involving the measurement of the rate of approach to equilibrium. Another technique described was the 'osmotic balance' method, in which the diffusion of liquid into the cell is determined by weighing instead of by measurement. This method was claimed to give remarkable sensitivity, and should prove useful for the determination of molecular weights hitherto considered to be beyond the range of investigation by osmotic methods.

Among a number of papers dealing mainly with the technical evaluation of the properties of rubbers, many questions of interest to the physicist were touched on. Particular mention may be made of two papers on the resistance of rubber to tearing, by Dr. J. M. Buist and Dr. H. A. W. Nijveld, respectively, and one by Dr. J. R. Scott and Mr. R. W. Whorlow on the interpretation of plasticity measurements.

Chemical Aspects

Although most aspects of the chemistry of elastomers were implicit in the many matters discussed from a technological point of view, the actual contributions to rubber chemistry were limited to the three main topics of oxidation, vulcanization and rubber halides. There were also some subsidiary advances in chemical knowledge in the more technical discussions on synthetic rubbers and on latex.

On the subject of oxidation, papers presented by Dr. R. L. Stafford and by Dr. J. Le Bras and Mr. A. Salvetti were both primarily concerned with the mode of action of inhibitory substances. It has been suggested that in rubber chemistry the latter fall into two distinct classes, termed antioxidants and deactivators respectively, typical examples being phenyl-β-naphthylamine and mercapto-benzimidazole. The former fulfil the normal function of retarding oxygen attack, whereas the latter reduce the deleterious chain-scission reactions associated with oxidation of rubber without lessening the overall combination of oxygen. Much of the earlier work on the autoxidation of rubber and allied substances has been carried out with strong sources of light (for example, ultra-violet), thus giving a reaction which proceeds at a rate many times that of the dark reaction and which is unretarded by the usual antioxidants. No fundamental change in the nature of the reaction or of the effect of antioxidants was encountered by Dr. Stafford when the oxidation was effected with a weak light source with the object of obtaining a rate of photo-activated absorption of the same order as that of the dark thermal reaction.

However, although neither phenyl-β-naphthylamine nor mercapto-benzimidazole (the antioxidant and deactivator studied) was effective against light-activated absorption, a mixture of the two was found to possess considerable efficacy. The precise mechanism of this effect, which is in accord with earlier work of Le Bras, is still unsolved.

For the study of these oxidation effects with rubber, Dr. Le Bras has designed an improved type of manometric apparatus in which the oxygen is generated as required by electrolysis of a concentrated solution of copper sulphate.

The chief difficulty in this type of work is the fluctuation in results occasioned by the variability of composition of crude natural rubber. Assistance in this direction was given by Mr. G. Martin, who described a simplified method of preparing pure rubber hydrocarbon for oxidation studies. The method involves addition, to the ammonia-preserved latex, of a soap, which displaces the protein from the

rubber particle surfaces, followed by repeated creaming, coagulation with acetic acid and extraction with acetone.

Considerable interest was shown in a paper by Dr. W. T. Chambers on the direct determination on a micro-scale of oxygen in rubbers. His method is an application of that of Unterzaucher involving reduction of the oxygenated compound with carbon, the resulting carbon monoxide being oxidized by iodine pentoxide and the liberated iodine estimated after oxidation to iodate. The ability to determine small percentages of oxygen directly, instead of by difference from the carbon and hydrogen figures, will be of great value in rubber oxidation studies. The accuracy of this method is of the order of $\pm 0{\cdot}01$ in the range 0–0·5 per cent oxygen and $\pm 0{\cdot}04$ in the range 1·0 to 2·0 per cent oxygen. This precision was not sufficient to show conclusively that the molecular breakdown of rubber on milling is always associated with oxidation, but Dr. Chambers was able to demonstrate this effect in one run with pale crepe rubber.

In his presidential address to the Conference, Sir Robert Robinson mentioned the advances that had been made in the knowledge of polymerization and the importance of the introduction of intermolecular cross-linking into natural and synthetic polymers. Dr. G. F. Bloomfield was able to present more evidence on the nature of the cross-links arising in the vulcanization of rubber with sulphur. In this connexion methyl iodide has proved a useful reagent for determining the type of C—S link present. Earlier work has shown that methyl iodide at 25° C. removes the sulphur from diallylic sulphides to form trimethyl sulphonium iodide, and since the latter is obtained from the reaction of methyl iodide with rubber/sulphur vulcanizates, it has in the past been assumed that diallylic groups must be present in appreciable numbers. The unreliability of this conclusion (which is, in any event, at variance with other vulcanization evidence) was made apparent by Dr. Bloomfield's demonstration of a similar formation of trimethylsulphonium iodide from compounds containing the sulphur atom between one allylic and one tertiary grouping. It is known that the reaction of polyisoprenic compounds with sulphur leads to the formation of cyclic and cross-linked sulphides, and the evidence presented in this work is consistent with the view that the allyl-tertiary sulphide grouping is a characteristic of both.

The importance of the non-hydrocarbon constituents of natural rubber in the process of vulcanization was demonstrated by Mr. G. Martin in his work on highly purified rubber. The catalytic effect of these other constituents, the absence of which was found markedly to reduce the vulcanizing efficiency of sulphur, is a subject requiring further careful investigation.

A study of the hydrochlorination of rubber in latex by Dr. G. J. van Veersen had theoretical as well as practical significance. The reaction of hydrogen chloride with rubber in solution shows an induction period, the length of which is proportional to the solubility of the hydrogen chloride in the solvent. It was suggested that a solution of rubber in dioxane (for example) represents a system of two electron donors competing for the hydrogen chloride to form co-ordination complexes. During the induction period, the speed of the reaction would be dependent on the affinity of the solvent for hydrogen chloride, but after saturation the rate would be independent of the nature of the solvent. In the reaction of hydrogen chloride with rubber latex it is necessary to prevent coagulation by reversing the charge on the rubber globules with a cationic soap. Under these conditions a very clean addition takes place with a minimum of cyclization.

It is difficult in a substance of high molecular weight like rubber to determine the nature of artificially introduced chemical groups. A contribution to this subject was made by Dr. G. Salomon, who read a paper by himself and Drs. C. Koningsberger and A. J. Ultée on the kinetic analysis of rubber halides. The method is based on the marked differences in reactivities of the various classes of aliphatic halides with organic bases. In the case of monohalides, this order is allylic>primary>tertiary (with some exceptions) > secondary > secondary monocyclic > vinylic. Polyhalides are more difficult to distinguish unambiguously, but their identification is rendered possible in many cases by comparison of the speeds of reaction with various bases. Using this kinetic method, evidence was found, for example, for the formation of secondary allylic chloride groupings in the chlorination of rubber under conditions favouring substitution, and of a series of polychlorides, the constitution of which has yet to be settled, by conventional chlorination.

The papers and discussion on synthetic rubbers were mainly technological in nature, although there were some points of chemical interest. Dr. R. P. Dinsmore directed attention to the fact that *GR–S* requires less combined sulphur than natural rubber to give a satisfactory vulcanizate, a point that may well be connected with the tendency of the $\Delta^{1:5}$ polyene system of rubber to give cyclic sulphides which contribute little to the strengthening of the molecular network. Mention was made of some of the physical and chemical properties associated with the characteristic structures of silicone, 'Buna-N' and butyl rubbers and of condensation rubbers of the type of 'Vulcaprene' (a di-isocyanate-modified polyesteramide).

An important contribution to our knowledge of the constitution of natural rubber latex was made by Miss L. N. S. Homans and Dr. G. E. van Gils. By centrifuging fresh unammoniated latex they were able to separate a yellow fraction which was a suspension mainly of non-rubber particles and which contained 6–8 per cent of the total solids of latex. These globules (termed 'lutoids') were easily visible under the microscope as transparent masses considerably larger than the rubber globules and were shown to consist of 80–85 per cent of water, with the solid content made up of proteins, salts and acetone-soluble substances, in the form of lipoids. Addition of ammonia brought the lutoids into solution, and dilution with water caused shrinking; but they were quite stable towards 0·1 *N* sodium chloride in aqueous solution. Removal of the lutoids resulted in marked changes in properties of the latex; for example, greater susceptibility to photoxidation, lower mechanical stability, greater thermal stability.

This new knowledge may have interesting biological implications in that it brings the constitution of latex more into line with the complexity of other physiological liquids.

A further attraction of the conference was an exhibition, arranged by the Dunlop Rubber Company, which included demonstrations of some of the more striking of the properties of rubber and methods by which they have been studied.

It is intended that the *Proceedings* of the Conference shall be published in a single volume. There is no doubt that this will prove a worthy companion to the *Proceedings* of the first conference, held in 1938, and a valuable source of reference to all interested in rubber science.

L. R. G. TRELOAR
R. F. NAYLOR

NUTRITION OF ATHLETES

A WHOLE-DAY meeting of the Nutrition Society on July 17 was devoted to the subject of the "Nutrition of Athletes". The first papers dealt with the physiology of muscular effort, and the meeting took a more practical turn later in the morning and in the afternoon session.

The meeting opened with a paper by Dr. Philip Eggleton of Edinburgh on "The Neuromuscular Mechanism". Physiological studies, he said, fall into three clear-cut categories. The first of these is the work on animals (including dog and man) which comprises measurements of work done, respiratory measurements, urine and blood analyses, nutrition studies and so on. The second category includes work on isolated muscles and nerves, which has been carried out mainly on cold-blooded animals because of the difficulty of using such preparations from mammals. Thirdly, there is work on the muscles of marine shell-fish. These last two methods have certain disadvantages in that it is difficult to apply the results obtained from them to the mammal, and particularly to the human being. Nevertheless, results from the three fields combine to produce a picture of the neuro-muscular machine which, according to the author, comes nearest to the physiologist's ideal—a description of physiological phenomena in terms of chemistry and physics—than has been achieved in respect of any branch of physiology, save perhaps the transport of gases by the blood.

Experiments in the first field have shown a simple relation between work done and food intake required; and there is also considerable evidence that manual labourers do not choose to eat carbohydrates but prefer fat and protein. This preference for a high protein diet by both manual labourers and athletes may be a survival perhaps of sympathetic magic; yet it may have as a basis the fact that meat is a good source of some of the B complex of vitamins. The preference for fatty food is more understandable, since it is an economical source of energy.

Dr. Eggleton went on to discuss A. V. Hill's work on the oxygen consumption during exercise, and said that in Hill's experiments the consumption of oxygen was about 4 litres a minute for men engaged in running at a pace which did not give them undue respiratory distress. However, these experiments only lasted for minutes, and Eggleton pointed out that the heart cannot pump 4 litres of oxygen into the body indefinitely; if the exercise has to be maintained for some time, an oxygen consumption of 1 litre per minute is nearer the upper limit. In this connexion Dr. Eggleton remarked that an athlete can build up an oxygen debt for events such as the 100-yd. sprint, and that in this event the rate of output of energy of the runner is 10–13 horse-power, which corresponds to an oxygen intake of 23 litres a minute—six times anything the heart can achieve. This debt is financed partly by the breakdown of glycogen to lactic acid and partly by the reserve of non-oxidative energy represented by the creatin phosphate content of muscle.

Dr. Eggleton discussed some of the aspects of the evolution of the neuro-muscular mechanism, and pointed out that one of the differences between invertebrate and vertebrate muscle is the presence of arginine in the muscles of the former and of creatine in muscles of the latter. Also vertebrate muscles contain considerable amounts of two di-peptides—β-alanylhistidine and β-alanyl-methyl-histidine—which are not present in invertebrate muscle.

In conclusion, Dr. Eggleton commented upon the apparent increasing athletic abilities of the human race, which he felt were more apparent than real, and upon the view that the decreased performances of British athletes recently is due to the changes in diet and habits engendered by the War, a problem which he felt should be left to later speakers.

Dr. Dorothy Needham spoke on chemical aspects of chemical contraction. In this field, Dr. Needham said that two lines of work, followed independently for about half a century, had only recently come together. One of these was the nature of the muscle machine, and the other was the nature of the essential fuel. Dr. Needham discussed the early work of Fletcher and Hopkins and of Meyerhof on the energy liberated by the formation of lactic acid in muscle, and of Lundsgaard's work on creatine-phosphate breakdown as a source of energy. Lohman's work in 1934, she said, suggested that adenosine triphosphate hydrolysis supplied the first energy-yielding reaction in muscular contraction.

The old idea that lactic acid production is an inevitable accompaniment of contraction has had to be discarded since it has been shown that much work can go on without any lactic acid formation. The most important constituent of the muscle machinery is the protein, and the modern phase began with the work of Edsall and von Muralt in 1930. Solutions of myosin showed the property of double refraction in flow, and this suggested some relation with the anisotropic bands of myo-fibrils. It appears that the contractile fibrils of muscle consist of polypeptide chains of myosin showing the α-fold, and owe their elasticity and contractility to their power of straightening out to the fully extended chain or folding up still further. The link between the machinery and the fuel comes from the observation that myosin has adenosine triphosphatase activity, so that myosin is not only the chief structural entity of muscle but is also the enzyme catalysing the chemical processes which lead to its own contraction. Szent-Györgyi has shown that another fibrous protein, 'actin', can be extracted from muscle, and that actin and myosin may unite to form fibrils of much greater length; this compound of the two proteins is called actomyosin.

It seems possible that some of the symptoms of fatigue may be due to the breaking of inter-molecular links which hold the partly folded polypeptide chains in place. If contraction is too severe and prolonged, too great a distortion may take place and unusual breaking of links or the formation of new and inconvenient ones may take place.

There are at the moment two main views on muscular contraction. One is that the contracting fibrils are made up of actomyosin. If adenosine triphosphate comes into contact with actomyosin fibrils, there is a rapid change of the protein with loss of water. Szent-Györgyi regards this as synonymous with contraction; on the other hand, Astbury has suggested that in resting muscle the fibrils are made

more rigid and stable by combination in parts with a parallel *actin*-system, and that upon stimulation this combination is loosened by the action of adenosine triphosphate. When this happens the myosin can take up a shortened form of folding.

Group Captain C. A. Rumball described the practical uses to which investigations on the neuro-muscular mechanism have been put in the choice of air-crews by the R.A.F. Pulse-rates while sitting, standing and under stress gave useful information. Diastolic blood pressures of more than 90 mm. were not acceptable, though up to 90 mm. was. However, it was pointed out that fifty-five marathon runners examined in 1909 had an average diastolic pressure of 93 mm. of mercury. One test which gave information of considerable value was that designed by Flack in 1920, in which a subject was asked to sustain a 40-mm. column of mercury in a U-tube manometer by a single expiration for as long as possible, and the pulse response examined. There are four main types of pulse response to this test; but only two of them, namely, a rapid and sustained rise to 10 or more beats per 5-sec. interval and a rapid rise followed by an abrupt fall to a low figure, indicated low functional efficiency.

Nutritional aspects of muscular activity were introduced by Dr. G. H. Bourne in a paper entitled "Vitamins and Muscular Exercise". Dr. Bourne pointed out that vitamins of the B complex play an important part in the reaction chains concerned with carbohydrate metabolism, and the demand for them might be expected to be increased in muscular exercise. A figure of fifteen times the normal requirement for vitamin B in severe exercise has been quoted. This would mean a daily intake of 22·5 mgm. (based on a normal daily requirement of 1–5 mgm. of vitamin B_1). To obtain this amount of vitamin B_1, one would need to consume 6½ kilos of National wheatmeal bread, ¾ kilo of commercial wheat germ or 90 gm. of dried brewers' yeast. One should consider, therefore, if these greatly increased demands for vitamins of the B complex do exist, and if they do, whether it would be possible for an athlete to obtain them from natural foods, with the possible exception of dried yeast. Perhaps, then, an athlete's performance is limited by his vitamin B complex intake, and this is itself limited by the amount of natural food he can eat. The consumption of quantities of meat, liver, eggs, etc., by athletes may be related not to the protein content of these foods, but to the relatively high amounts of various members of the vitamin B complex they contain.

If supplementation of athletes' diets is undertaken, it should be remembered that there is some evidence that certain vitamins may have a supra-physiological or pharmacodynamical action, which may or may not be related to their normal nutritional function. Inspection of the literature on the effects of supplementing the diet with various vitamins of the B complex shows no uniformity of results; but on the average there does seem to be a bias in favour of the beneficial effect of these vitamins on muscular exercise.

Attempts to show that extra doses of vitamin C increased resistance to fatigue have also been equivocal; but there seemed to be some evidence in favour of its use.

There is little doubt that deficiency of most vitamins seriously affects muscular effort; but the difficulty is in deciding just at what level of intake deficiency exists.

Dr. Bourne felt that the subject of nutrition of athletes, with its obsession with calories and proteins, is lagging considerably behind modern advances in nutritional science.

In the afternoon, Sir Adolphe Abrahams asked what indication there was for a high calorie diet for athletes, what foodstuffs should predominate in it, and thirdly, what part, if any, alcohol should play in the diet of athletes?

On the question of calories, Sir Adolphe said that the figures published of the calorie intake of athletes at the Berlin Olympiad in 1936, which were said to have been compiled from observations on 4,700 competitors, were extraordinary. They quoted a daily average intake of 800 gm. of meat, 150 gm. of sugar, 150 gm. of butter, 1–1½ litres of milk, vegetables and fruit *ad lib.*, making a grand total of 7,300 calories. Such an intake is really equivalent to the requirements of a 24-hr. walking race, or daily violent physical exercise of six hours duration. In fact, no athlete in training undertakes six hours violent physical exercise a day. Most athletes visit the track twice a day. The sprinter does a few bursts from the start and a run through of 150 yd. each time, and few of even the long-distance men do really hard work during their training period. Events such as the annual Oxford and Cambridge boat race only use up about 500 calories per man. Athletes, therefore, do not need vast quantities of food; but a generous diet is desirable from a psychological point of view.

Discussing the role of meat in the diet, Sir Adolphe pointed out that athletes who claimed to be vegetarians invariably consumed milk, cheese and eggs, containing animal protein. He felt that extra sugar is not of particular benefit to athletes. The men of to-day are not better physically than the men of fifty years ago, and Sir Adolphe felt that the explanation of improved records is partly due to improved technique and partly to the increasing growth of the cult of athleticism.

The final paper of the day was given by Dr. Nevil Leyton on "Some Practical Aspects of the Training of Athletes". Dr. Leyton made the important point of the difference in individual calorie requirements for the performance of the same task, and the difference in the times before events that individual athletes require to eat. The actual calories for the Oxford and Cambridge boat race may be as much as 600 per man; this figure may be compared with that for a Marathon race, when 2,000 calories may be used. A five-set tennis match may use 1,200 calories. In addition, the body may continue to expend energy at a higher rate than normal for 24–48 hours after the event. A good training diet should nourish the athlete adequately during this period and should include fruit and vegetables, the function of these being partly to provide vitamins. Some consideration must also be given to the possibility of assisting the athlete during the contest. A 20-min. all-out effort uses about an ounce of sugar. So a marathon runner may use nearly 5 oz. in a race. Four ounces of sugar may be absorbed from the gut in about two hours. Some benefit should accrue to performance if an athlete is given sugar an hour or two before an event. Even if calories can be provided in sufficient amounts, it is often difficult in Britain to-day to provide an athlete with just the food he feels he wants, and this may have an adverse psychological effect.

The day's discussions were ably summed up by the chairman, Prof. J. R. Marrack.

SHORTAGE OF SCIENTIFIC TEXT-BOOKS IN CAMBRIDGE

A SURVEY carried out in Cambridge during March–April among teaching staffs and booksellers shows that nearly half of the scientific books the average student is recommended to buy are not available for him to buy new. It also shows that American books cover 33 per cent of all books students are recommended to buy, as opposed to 10 per cent before the War.

Teachers from twelve scientific departments of the University supplied lists of recommended text-books and also indicated the annual number of students likely to require each book. 145 titles were listed in all, 97 being of British origin and 48 American. Some books were, of course, alternatives to others, but the 145 titles covered 128 separate 'topics'.

The availabilities of American and British books depend upon different factors and were, therefore, estimated by different methods. Booksellers stated that the *number* of American books demanded has approximately doubled since 1939, whereas their average *price* has risen by about 50 per cent. Thus the current demand is about 300 per cent by value of the pre-war demand. Since permitted imports are now 200 per cent by value of pre-war imports, it is estimated that approximately two-thirds or 67 per cent of the American books now required are available. In other words, a student requiring an American book has, on the average, a two-thirds chance of obtaining it; a particular student may, of course, do better than this, either by good luck or by his own efforts. The above estimate neglects the possibility that an American book is out of print. The number of such books is small, and, in any event, should affect neither the total imports of American books nor the average availability in Great Britain. Also, no account is taken of books imported as single copies direct from the United States to the British purchaser; this factor is not thought to be important so far as students are concerned.

With the co-operation of booksellers, the British books were classified as: (1) available for immediate sale; (2) reprinting or new edition in preparation; (3) out of print. The data thus obtained referred to a particular date (early April 1948); but it seems probable that the percentage availability of a large sample of books at any one time will give a fair measure of their average availability over a period, individual fluctuations cancelling one another out. In fact, the availability found for the particular date agreed with the booksellers' own independent impression of the general position. Further, unless major changes in policy occur, of which there is no indication, the estimates should also hold for the near future. The student may, of course, be able to get second-hand copies, but this factor also does not seem to be of major importance, especially since students now finishing their courses are stated to have a greater tendency than formerly to keep their books. The data obtained refer to a wide range of subjects, but analysis showed that the position is not significantly different as between (1) physical and biological sciences, (2) books required by a large number of students (more than fifty copies a year) and those required by fewer.

Of the 128 'topics' analysed, 55 were available in British books. 48 were unavailable in British books and no American alternative was mentioned (of the 48 'topics', 33 books were reprinting and 15 were out of print). For the remaining 25 'topics', only American books were in print and it was assumed that 17 of these were actually available and 8 not available (that is, a 67 per cent availability as stated in a previous paragraph). Hence only 72 (55 plus 17) out of the 128 'topics' were available in any form, that is, 56 per cent.

As stated above, 97 of the 145 titles were British, and 56 per cent of these were available. It will be noted that this compares unfavourably with the percentage availability of American books (67 per cent). It is of further interest that about 50 per cent of the American books were listed as alternatives to British books, and about 20 per cent of the British books were given with American alternatives. Both booksellers and teachers confirmed that the demand for American books has considerably increased since before the War and now represents about 33 per cent of the total demand, as opposed to 10 per cent before the War.

The survey comments that the advantage that American books have over their approximate British alternatives is due primarily to the paper shortage and other obstacles to British book production, coupled with the lack of priority as to subject-matter in the allocation of paper to British publishers. This lack of discrimination at home stands in marked contrast to the complete discrimination in favour of learned, scientific and technical books when imported from abroad. The supplies of British text-books are affected both by low production and high export. Out of a total value of more than £30 million for books of all types produced in Britain in 1947, 24·5 per cent was exported (*The Bookseller*, March 20, 1948). The proportion of British book production (all types) exported was as high as 35 per cent in 1940 and 29 per cent in 1941 (*The Bookseller*, March 20, 1948). The much-enhanced position of American scientific books in the British market dates from that time. It has not been seriously affected by the short period in which imports were cut to 100 per cent of pre-war value. American publishers are continuing to press their advantage, arising from Britain's production difficulties and her need to export.

Many of the newer American books are, of course, invaluable, and no British alternative exists. This is especially true of up-to-date scientific and technological works of reference. In this respect American books have an advantage over British ones, quite apart from Britain's immediate production difficulties and need to export. In great part, of course, the advantage arises from the larger scale of American industrial and scientific activity generally, and hence the greater number and variety of specially qualified authors. Nevertheless, there are other, less unavoidable, reasons for the relative paucity of new British advanced works. Delays in publication put British books at a disadvantage by increasing the chances that a new American book will have arrived and satisfied the demand in a subject before an already-written British book on that subject appears. Furthermore, inquiries in Cambridge indicate that new British works are not being *written* in numbers commensurate with our supply of qualified authors. An important deterrent mentioned was lack of time and (not so important) lack of financial inducement. Increased teaching pressure leaves little time for the writing of new books and makes it difficult for those who fell behind in their reading while on war-work to catch up again. The direct financial inducement to write

advanced scientific works was never great; but to-day it is smaller than ever. Publishers try to share out their limited paper among the most needed titles, and the consequent small impressions mean correspondingly small royalties. The survey suggests that official encouragement should be given to the writing of new books by British specialists.

It is stated that a good case can be made out for the large percentage of book production which goes to export. It is emphasized, however, that this trade and, even more important, this reputation, are in danger unless our total volume of 'learned, scientific and technical' book production is increased both in number of copies of existing standard works and in new titles. The value of American exports of books (all types) to all countries had not in 1947 quite equalled Britain's; but 1947 was the year in which the import of America's books was artificially restricted by two of her best customers, Britain and Australia. In spite of that, American exports rose more steeply than our own. With British import restrictions relieved, American exports may be expected to surpass Britain's. Moreover, America can, as Britain cannot, increase the exported fraction of her total production without serious consequences for the home consumer. America's exported fraction was only 7 per cent of the total (in 1946) as against Britain's 25 per cent. The conclusion is drawn that it is essential that British scientific book production should be increased by giving priority in material allocation to the publication of such books, so that both the home and export markets may be better supplied.

This survey was carried out by the Cambridge Branch of the Association of Scientific Workers, and copies of the complete survey are available from the Head Office of the Association (15 Half Moon Street, Piccadilly, London, W.1). R. INNES

NEWS and VIEWS

Physiology at the London Hospital Medical College: Dr. John L. D'Silva

DR. JOHN L. D'SILVA, reader in physiology at St. Bartholomew's Hospital Medical College, who has been appointed to the chair of physiology at the London Hospital Medical College, was born and educated in southern India. He graduated with first-class honours in chemistry at King's College, London, in 1929, and remained there for a further three years doing research on the chemistry of disulphides. In 1932 he went over to physiology, still at King's College, carrying out investigations on the effect of adrenaline on the metabolism of potassium. After a short period with Messrs. British Drug Houses, Ltd., spent on research into the molecular distillation of fish oils in connexion with the study of vitamin A, he went in 1936 to St. Bartholomew's Hospital Medical College, where he was demonstrator in physiology and in biochemistry, and continued his work on the metabolism of adrenaline and potassium. He was awarded the degree of D.Sc. for his published work. During the Second World War, Dr. D'Silva qualified as a medical practitioner and also continued teaching. After work at St. Bartholomew's Hospital, in 1944 Dr. D'Silva was appointed to the Medical College again and has remained there since, lecturing and carrying out research on the physiology of the visual process.

Jöns Jakob Berzelius (1779–1848)

WHEN he died a century ago on August 7, 1848, Berzelius was not only the most famous chemist of the world, but also the autocrat of the world of chemistry. The son of a schoolmaster, he was born near Linköping on August 29, 1779. After studying medicine and chemistry at Uppsala, at the age of twenty-three he was appointed assistant professor of botany and pharmacy at Stockholm, and full professor in 1807. During 1815–32 he held the chair of chemistry in the Caroline Medico-Chirurgical Institution. In 1818 he became perpetual secretary of the Stockholm Academy of Sciences, and received a title of nobility, with permission to retain his name. Seventeen years later, on the occasion of his marriage, he was made *Freiherr*. Berzelius spent some ten years determining with great accuracy the atomic and molecular weights of more than two thousand chemical substances; he isolated selenium, thorium, silicon, titanium and zirconium, and also prepared and examined many organic compounds. He devised the present system of chemical symbols. His "Lehrbuch der Chemie", begun in 1808, went through five editions and, in various translations, spread his fame over Europe. His dualistic electrochemical theory exerted a profound influence on the progress of chemistry. Though Berzelius worked in the simplest of laboratories, his reputation attracted students from many countries. In his hands the blow-pipe became the symbol of qualitative dry analysis. Distinguished in appearance, inclined to be portly, neat in attire and habits, cordial and unassuming, Berzelius was vigorous in body and mind, though essentially conservative in his outlook. Of his characteristic sayings the following may serve as a sample: "The devil may write text-books of chemistry, for every few years the whole thing changes".

Australian Journal of Scientific Research

THE Australian Council for Scientific and Industrial Research, in collaboration with the Australian National Research Council, has decided to take responsibility for the establishment in Australia of a new scientific journal, the *Australian Journal of Scientific Research*, as a medium for the publication of research papers of outstanding merit. This journal is open to receive contributions from research workers, irrespective of country or of the organisation to which they are attached. Dr. N. S. Noble has been appointed as editor of the new journal. Editorial policy will be determined by an editorial board under the chairmanship of the editor and comprising as members: Prof. W. J. Dakin (Department of Zoology, University of Sydney), Prof. E. J. Hartung (Department of Chemistry, University of Melbourne), Prof. L. H. Martin (Department of Physics, University of Melbourne), and Prof. J. G. Wood (Department of Botany, University of Adelaide). The Board aims at achieving a high standard of quality in papers accepted and a strict refereeing system has been instituted. The *Journal* will be printed in two series: Series A (Physical Sciences) and Series B (Biological Sciences). Initially each series will be issued quarterly and will cost 30*s*. a year.

Birkbeck College Research Laboratory

By the aid of a gift from the Nuffield Foundation, Birkbeck College (University of London) has been enabled to equip and staff two houses in Torrington Square, London, W.C.1, as a Biomolecular Research Laboratory under the direction of Prof. J. D. Bernal. The main work of the Laboratory will be the application of physical methods, particularly X-ray analysis, to the understanding of the structures and reactions of molecules in biological systems. X-ray methods are being used in two ways, namely, the study of the mutual relations in space of virus molecules in solution and in solid phases by low-angle diffraction; and the investigation of the internal structure of the molecules themselves by high-angle diffraction. In addition to the study of molecules directly connected with proteins, others of more general biological interest are also being examined by modern X-ray analytical methods, as well as other structures chosen to develop methods of X-ray crystal analysis. To make the fullest use of existing techniques and to develop further experimental and theoretical tools for this purpose, two sections devoted to electronics and computation respectively have been added to the Laboratory. The design has already been completed of an electronic computing machine of such speed that complete analysis of complex structures by the method of 'steepest descents' can be carried out in a reasonable time. Another section of the Laboratory is working on the fundamental structure of the active constituents of Portland cement, and the nature of their reaction with water; this investigation is being financed by the Department of Scientific and Industrial Research. The work is not so isolated from the main interests of the Laboratory as may at first sight appear; for already it has been found that the properties of hydrated cements are closely related to those of many biological gels and are strongly influenced by the same long-range forces. Part of the two houses now taken over by Birkbeck College to provide for these investigations is being devoted to chemical research under Prof. W. Wardlaw and will also furnish facilities for chemical work in connexion with the biomolecular studies.

The new Laboratory was formally opened by Sir Lawrence Bragg on July 1. Sir Lawrence welcomed the initiation of a new Laboratory which is to study biomolecular substances, because such borderline subjects between physics, chemistry and biology are becoming so very important. There is always a difficulty in attracting first-rate young research workers into borderline subjects, because they tend to classify themselves as physicists, chemists or biologists and take up research accordingly. Probably the best way of overcoming this difficulty would be to provide first-rate centres of research, directed by well-known scientific workers, for such subjects.

Rubber Technology Conference

Elsewhere in this issue (p. 204) an account is given of some physical and chemical aspects of the contributions to the Rubber Technology Conference held in London during July 23–25. The Conference was attended by no less than 609 members, including 119 from abroad. This compared very favourably with the previous Conference in 1938, when 553 members attended. On the occasion of the 1938 Conference more than a hundred papers were presented, and this necessitated two simultaneous sessions. This year there were only forty-three papers spread over eight sessions running consecutively. An outstanding feature of the Conference was a demonstration of physical and chemical properties of rubber on June 23 arranged by Mr. E. F. Powell and certain members of his staff from the Dunlop Rubber Co., Ltd. The Conference closed with a dinner at the Connaught Rooms, London, on the evening of June 25; Mr. F. D. Ascoli, president of the Institution of the Rubber Industry, presided. During the evening, the Colwyn Medal of the Institution was presented to Dr. R. P. Dinsmore of the Goodyear Tyre and Rubber Co. of the United States. This is the sixteenth award of the Medal and the first time that it has gone to an American.

Earthquakes during May

During May ten strong earthquakes were registered at observatories throughout the world, and there were numerous smaller shocks and tremors. The greatest earthquake which was registered at Kew gave ground amplitudes of 110 μ at Kew on May 14 and came from a focus the epicentre of which was south of the Alaska Peninsula (lat. 54½° N., long. 161° W.). A world-shaking aftershock of this came on May 17 from a focus the epicentre of which was perhaps slightly to the north of the original. The second most intense shock of the month was the one which occurred on May 11, starting from a focus with epicentre near lat. 17° S., long 71° W. in southern Peru. The focus of this earthquake was a little deeper than normal; the instrumental strength of the shock was almost 7½, and casualties and damage were caused at Moquegua in southern Peru and at Arica and Tacua in northern Chile. The third greatest earthquake shock of the month happened on May 25 from a focus having an epicentre near lat 30° N., long. 99½ E. in Sikang Province in China. A much less intense earthquake on May 28 from a focus with epicentre at lat. 12° S., long. 77° W. did damage to property and caused the deaths of five people in Peru. The deepest focus earthquake of the month occurred on May 23 from a focus some 200 km. deep with epicentre near lat. 18° S., long. 169° E. More feeble shocks occurred on May 23, doing damage to property in both islands of New Zealand; on the morning of May 24, throwing people out of bed at Palermo in Sicily; and on May 25, off the west coast of Oregon. Data for the month have been received from the U.S. Coast and Geodetic Survey, the International Seismological Bureau at Strasbourg, and observatories at Beograd, De Bilt, Durham, Kew, Stuttgart, Toledo and Uccle.

Cleveland Seismological Observatory

In 1946 gifts from the Louis D. Beaumont Trust and the Cleveland Foundation financed the purchase of three electromagnetic seismographs of the Sprengnether type for the Cleveland Seismological Observatory, which is situated at lat. 41° 29′ 27·90″ N., long. 81° 31′ 52·22″ W. (geographic co-ordinates) at an altitude of 1,070 ft. on University Heights, Cleveland, Ohio. The geocentric latitude is 41° 18′ N. The staff at present consists of the Rev. Henry F. Birkenhauer, *S.J.* (director), Rev. Joseph S. Joliat, *S.J.* (associate director), Dr. Edward J. Walter (assistant director), Mr. Richard Becka and Miss Jeanne Carrabine. The publication of monthly teleseismic bulletins and monthly microseismic reports has already begun.

New Tropical Fungi

THE various regions of Central Africa are a territory which has not been studied mycologically in any detail. It is therefore not surprising that, in a second paper on tropical fungi, G. B. Hansford (*Trans. Linn. Soc. Lond.*, **159**, pt. 1, pp. 21; 1947), in describing thirty-four species, includes no less than twenty-eight new ones. The genus *Meliola* is well represented with eight new species, and it has been found necessary to create two new genera, *Phragmodiscus* and *Dictyoasterina*, to accommodate some of the new findings. The collections are from Uganda, the Belgian Congo and Sierra Leone.

University of Leeds

THE Council of the University of Leeds has announced that the Wool Industries Surplus Cloth Corporation, Ltd., has given a sum of £40,500 for the establishment in the University of a research chair of wool textile engineering within the Department of Textile Industries. Other gifts include £10,000 from the International Wool Secretariat (in addition to a similar amount already received) for the purpose of completing the cost of equipping the new Wool Research Laboratories; 1,000 dollars from the Ella Sachs Plotz Foundation for the purchase of equipment for the Department of Biochemistry; £250 from Messrs. J. and J. Crombie of Aberdeen, for the Textile Department; £2,126, handed over by the Leeds Public Dispensary and Hospital, being the balance of the Research Appeal Account, which the Council agreed to earmark for rheumatism research; £300 a year from Sandoz Products, Ltd., of Bradford, to provide a scholarship for a male candidate to take the form of three consecutive two-year awards; 500–600 plastic mouldings for experimental research in speech training, presented to the Department of Education by Messrs. Birkby's, Ltd., of Liversedge.

University of London: Appointments

THE following appointments in the University of London have been announced: Dr. D. V. Glass, reader in demography at the London School of Economics and Political Science, to the University chair of sociology tenable at the School; Mr. E. P. Sharpey-Schafer, physician and senior lecturer at the Postgraduate Medical School of London, to the University chair of medicine tenable at St. Thomas's Hospital Medical School; Dr. D. S. Bertram, lecturer in the Department of Entomology and Parasitology in the Liverpool School of Tropical Medicine, to the University readership in entomology tenable at the London School of Hygiene and Tropical Medicine; Dr. F. L. Warren, senior lecturer in biochemistry in the Physiology Department of St. Mary's Hospital Medical School, to the University readership in biochemistry tenable at University College. All these appointments take effect on October 1, 1948.

The titles of emeritus professor in the University have been conferred on the following: Prof. A. B. Appleton, on his retirement from the chair of anatomy at St. Thomas's Hospital Medical School; Prof. O. L. V. de Wesselow, on his retirement from the chair of medicine at St. Thomas's Hospital Medical School; Prof. F. E. Fritsch, on his retirement from the chair of botany at Queen Mary College; Prof. D. T. Harris, on his retirement from the chair of physiology at the London Hospital Medical College; Prof. T. Baillie Johnston, on his retirement from the chair of anatomy at Guy's Hospital Medical School; Prof. W. Neilson Jones, on his retirement from the Hildred Carlile chair of botany at Bedford College.

The following doctorates have been conferred: D.Sc.: J. R. Busvine (Imperial College of Science and Technology); D.Sc.(Eng.): D. G. Tucker (external student).

Beit Memorial Fellowships for Medical Research

THE following elections have been made by the Beit Memorial Trustees: *Senior Fellowship* (£900 a year): Dr. F. Sanger (Cambridge), to study the structure of proteins with special reference to insulin, at the Department of Biochemistry, University of Cambridge. *Junior Fellowships* (normal value £600 a year): D. A. Darcy (Dalhousie, Canada), to study the role of the lymphocyte and plasma cell in homograft breakdown, at the Department of Zoology and Comparative Anatomy, Oxford; R. M. C. Dawson (London), to study biochemical changes in the brain associated with different forms of functional activity, at the Biochemical Laboratories, Cardiff City Mental Hospital; F. N. Fastier (New Zealand), to study the nature of the musculotropic action of basic amidine derivatives, at the Department of Pharmacology, Oxford; Dr. L. J. Haynes (London), to study the synthesis of the coenzyme, cozymase, at the University Chemical Laboratory, Cambridge; Dr. A. T. James (London), to study the relationship between structure and biological activity in naturally occurring substances, at the Lister Institute of Preventive Medicine, London; A. McCoubrey (London), to study analgesic and addictive tendencies from a chemical point of view, at the Departments of Organic Chemistry and Pharmacology, University of Leeds; S. W. Stanbury (Manchester), to study the effect of changes in nervous activity, induced by narcosis and sleep, on the renal circulation and blood pressure in normal and hypertensive individuals, at the Department of Medicine, University of Manchester; D. Verel (Cambridge), to study the postural hypotension which may follow prolonged rest in bed, at the Clinical Research Unit, Guy's Hospital, London.

Announcements

THE Joint Committee consisting of representatives from the Royal Society of Edinburgh, the Royal Physical Society, and the Royal Scottish Geographical Society have awarded the Dr. W. S. Bruce Memorial Prize to Dr. W. A. Deer, Department of Mineralogy and Petrology, University of Cambridge, for his work in East Greenland during 1935–36, especially in regard to the petrology of the Skaergaard gabbro intrusion.

THE Faraday Society is arranging a general discussion on "The Physical Chemistry of Process Metallurgy" to be held at Ashorne Hill, near Leamington Spa, by permission of the British Iron and Steel Federation, during September 23–25. Further particulars can be obtained from the Secretary, Faraday Society, 6 Gray's Inn Square, London, W.C.1.

THE postgraduate lectures for 1948 of the London Section of the Oil and Colour Chemists' Association will be delivered by Prof. H. J. Emeléus, on September 30, October 7 and 14 at 6.30 p.m., at the Royal Institution. Prof. Emeléus will speak on "The Impact of Radioactivity on Inorganic Chemistry". Admission will be by ticket (price 10s.) obtainable from the honorary secretary of the London Section of the Association, H. C. Worsdall, c/o Messrs. Plastanol, Ltd., Crabtree Manorway, Belvedere, Kent.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Properties of a Hypothetical di-Neutron

THE question of the possibility of obtaining experimental evidence for the existence of a neutral particle of mass 2 has recently been raised by Kundu and Pool[1]. These authors suggest that certain features of nuclear transformations produced by bombardment by tritium (^3H) ions favour the conclusion that a di-neutron having at least transient existence may be captured as a single entity in a nuclear process of an Oppenheimer – Phillips type.

It is the object of this note to point out that the β-active species ^6He, though stable against the spontaneous emission of neutrons of normal mass (stable, that is, against the process $^6He \rightarrow {}^5He + {}^1n$), is unstable against the emission of a di-neutron which has more than a relatively small energy of binding, so that the presumption that a di-neutron is not, in fact, emitted by ^6He (based on the evidence of its 'long' life-time) sets an upper limit to the binding energy of this hypothetical particle. In deducing this limiting energy, we may consider the reactions :

$$^9Be\ (+\ h\nu) \rightarrow {}^8Be + {}^1n + Q_1$$

$$^8Be \rightarrow 2\,{}^4He + Q_2$$

$$^9Be + {}^1n \rightarrow {}^6He + {}^4He + Q_3.$$

Obviously we have

$$^6He \rightarrow {}^4He + 2\,{}^1n + Q_1 + Q_2 - Q_3;$$

and inserting experimental values, $Q_1 = -1{\cdot}63$ MeV. [2], $Q_2 = 0{\cdot}12$ MeV. [3], $Q_3 = -0{\cdot}8$ MeV. [4], we obtain

$$^6He \rightarrow {}^4He + 2\,{}^1n - 0{\cdot}7\ \text{MeV}.$$

This last figure ($0{\cdot}7 \pm 0{\cdot}2$ MeV.) is the upper limit to the binding energy in question—a very much smaller binding energy than that of the deuteron (2·17 MeV.).

In terms of these last two binding energies, we can proceed to set limits to the energy available for the β-disintegration of a quasi-stable di-neutron (^2_0n). Clearly we have

$$^2_0n - {}^2H + Q_4 = {}^1n - {}^1H + 2{\cdot}17\ \text{MeV}.;$$

where $^1n - {}^1H = 0{\cdot}76$ MeV. and, as above obtained, $0 < Q_4 < (0{\cdot}7 \pm 0{\cdot}2)$ MeV. Thus $(2{\cdot}2 \pm 0{\cdot}2) < (^2_0n - {}^2H) < 2{\cdot}93$ MeV. This estimate allows us to predict the life-time (τ) of the di-neutron on the reasonable assumption that the transition

$$^2_0n \xrightarrow{\beta} {}^2H$$

is super-allowed[5]. In this way we obtain $1 < \tau < 5$ sec.

From the fact that ^6He is sufficiently long-lived to exhibit β-activity, we have thus deduced quite narrow limits for the radioactive constants of the hypothetical di-neutron. It might be added that, if such a particle should exist, it would be expected to be produced in $(^1n, {}^2n)$ reactions over a small range of neutron bombarding energy, in each case just below the absolute threshold energy for the corresponding $(n, 2n)$ reaction—and even at energies somewhat above these absolute thresholds, because of the requirement that the first neutron emitted in an $(n, 2n)$ process shall be emitted with finite energy. But, above all, search for the di-neutron might most conveniently begin with beryllium under neutron bombardment, not only because the $(n, 2n)$ threshold is lowest with this element (which makes possible the use of a D—D neutron source, which is free from γ-radiation), but also because the possibility of producing ^6He in an excited state in this case opens the further possibility (see above) that the di-neutron may be obtained as a secondary disintegration particle following upon the reaction ^9Be $(^1n, {}^4He)$ $^6He^*$. This possibility is unique just because the mass number 5 is the only mass number for which a neutron-stable species does not exist ; thus the excitation necessary to render ^6He unstable against the successive emission of two neutrons of normal mass is correspondingly increased.

As regards possible methods of detecting a di-neutron, it is perhaps out of place in this note to offer detailed suggestions. But apart from its spontaneous radioactivity (the half-value period of which is reasonably short) a quasi-stable di-neutron might be expected to produce nuclear transformations which in certain cases might be sufficiently characteristic to be used for its identification. Thus activities might be induced in effectively simple elements (such as ^6He in helium, ^{25}Na in sodium, ^{106}Rh in rhodium, ^{211}AcC in bismuth, for example) for some of which large capture cross-sections might apply. It might even be possible, investigating suitable substances under deuteron or α-particle bombardment at energies in the neighbourhood of the $(d, 2n)$ or $(\alpha, 2n)$ thresholds, to work under conditions in which the flux of di-neutrons was comparable with the normal neutron flux. In such circumstances comparison of the pulse-size distributions due to the recoil particles in hydrogen- and deuterium-filled ionization chambers might be used to effect a clear-cut identification.

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June 15.

[1] Kundu and Pool, *Phys. Rev.*, **73**, 22 (1948).
[2] Myers and Van Atta, *Phys. Rev.*, **61**, 19 (1942). Wiedenbeck and Marhoefer, *Phys. Rev.*, **67**, 54 (1945).
[3] Hemmendinger, *Phys. Rev.*, **73**, 806 (1948).
[4] Allen, Burcham and Wilkinson, *Proc. Roy. Soc.*, A, **192**, 114 (1947).
[5] Feather and Richardson, *Proc. Phys. Soc.*, in the course of publication.

Propagation of Pulses of Second Sound in Liquid Helium II

PRELIMINARY measurements of the velocity of second sound in this Laboratory using a resonator of fixed length and signals of a variable frequency have given results in good agreement with the resonance measurements of Peshkov[1] and of Lane, Fairbank and Fairbank[2]. In the course of these experiments it became apparent that if measurements were to be extended below 1° K., some method would be necessary which used a smaller mean power input. It can be shown, too, that the amplitude of temperature oscillation obtained in a resonance experiment is governed entirely by damping, and provides little information about the propagation of travelling waves in the medium.

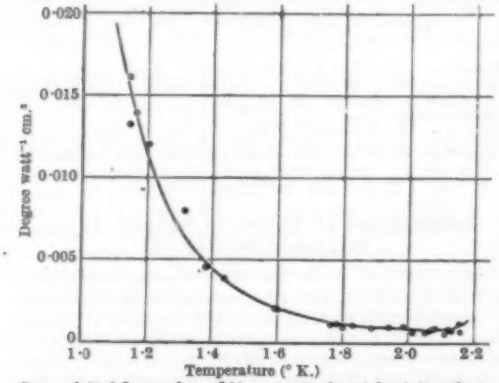
With these considerations in view, a technique has been developed for transmitting and receiving pulses of second sound. The signals are generated by applying a direct current pulse of 0·1–1 millisecond duration to a fine wire heater. The second sound pulse travels down an ebonite tube about 5 cm. long filled with liquid helium II, and is received by a phosphor bronze resistance thermometer which carries

a steady direct current. The change of resistance causes a voltage pulse to appear across the thermometer and, after suitable amplification, this is displayed on a cathode ray tube. Using standard radar techniques, it is a simple matter to time the pulse on its journey and hence to measure its velocity. The velocity results, which cover the range 1·1°–2·16° K., are in good agreement with those of earlier workers using the resonance method, and need not be reproduced here.

The more interesting feature of this method is the information which it provides about temperature amplitudes. It can be shown very simply, by considering the propagation of a unit step of temperature, that the power flow per unit area, W_1, must be connected with the temperature amplitude, T_1, by the relation

$$\frac{T_1}{W_1} = \frac{1}{\rho c u_2},$$

where ρc is the specific heat per unit volume of liquid helium and u_2 is the velocity of second sound. This relation is independent of any special theory of second sound and assumes only the propagation of a unit step without change of shape. The temperature amplitude ($\sim 10^{-3}$ ° K.) can be deduced experimentally from the size of the output signal, the gain of the amplifier and the calibration of the thermometer wire. The power fed in during the pulse ($\sim 0{\cdot}1$ watt cm.$^{-2}$) can be deduced from measurements of the voltage applied to the heater and of the heater resistance. The full line in the accompanying diagram gives $1/\rho c u_2$ (calculated from the known values of ρc and u_2) as a function of temperature, while the points are the experimental values of T_1/W_1. The agreement is well within experimental error.



Curve plotted from values of $1/\rho c u_2$; experimental points, values of T_1/W_1

Experiments are in hand to study the possible dispersion and absorption of second sound and to extend the velocity measurements to the range below 1° K. A combination of such velocity measurements with amplitude measurements may, on the basis of the above equation, provide a convenient method of determining the specific heat of liquid helium below 1° K.

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Cambridge.
June 22.

[1] Peshkov, V., Phys. Soc. Camb. Conf., 19 (1946).
[2] Lane, C. T., Fairbank, H. A., and Fairbank, W. M., *Phys. Rev.*, **71**, 600 (1947).

Emission Schumann – Runge O_2 Bands

Following on a recent contribution in *Nature*[1], it seems desirable to report briefly some work carried out in this laboratory and shortly to be published elsewhere in detail. Lalji Lal[1] has produced the Schumann – Runge bands of O_2 from 2450 A. to 4490 A. using a high-frequency discharge. He reports new bands which he has identified from small glass and quartz spectrograms.

I have photographed the Schumann – Runge system from 2000 A. to 5000 A. on a quartz Littrow (Hilger *E*.1) spectrograph, and this dispersion has been found sufficient for adequate resolution of the rotational structure of the bands. The spectra were excited by a high-voltage low-current arc in oxygen at atmospheric pressure. This source emits the bands so well that they occur even when the arc chamber is filled with air. In addition to the bands measured by earlier workers, the following bands have been found: (2, 22), (1, 12), (0, 11), (1, 11), (0, 10), (1, 10), (2, 10), (0, 9), (1, 9), (2, 9), (1, 8), (2, 8), (2, 7), (3, 7), (2, 6), (3, 6), (3, 5). Though some of these bands fall in the region investigated by Lalji Lal, his analysis does not correspond to that given here. However, bands of high v' will be more easily excited in the low-pressure source since collision damping will be active at high pressures, and this may account for some of the differences. The present analysis seems to give the Franck–Condon parabola suggested by previous work, whereas Lalji Lal's bands are rather widely scattered in the v' v'' array.

On comparing Lalji Lal's wave-numbers with those calculated from the data of previous workers, some rather large discrepancies are found. An attempt was made to identify Lalji Lal's bands both on *E*.1 and small quartz (*E*.3) spectrograms, but no good coincidences were found; the same result was obtained when examining the *E*.2 photograph obtained by Wulf and Melvin[2]. Obviously the difficulty can only be removed either by photographing the high-frequency discharge at larger dispersion for a more accurate analysis or by direct comparison of high-frequency discharge and high-voltage arc spectrograms. The heads are so weak on the present spectra that analysis has been made by identification of the rotational structure of each band, and 'heads' that seem present with small dispersion are found, with higher dispersion, to be merely due to chance overlapping of structure from several bands.

It will be seen that the present interpretation of the bands shows that Flory's[3] suggestion of predissociation for $v' > 2$ is incorrect (this also follows from Lalji Lal's analysis). In the detailed publication referred to above, Flory's arguments are critically examined, and it is found that there is no difficulty in abandoning the predissociation hypothesis.

The bands are found to be very sensitive to pressure changes and are strongly emitted only at a pressure near atmospheric, unless specially pure gas is used to allow long exposures without the appearance of impurity spectra. This may be explained by the fact that normal O_2 molecules are dissociated by electronic collisions into $O(^3P)$ and $O(^1D)$ atoms, since a Frank–Condon transition from the ground-state ($^3\Sigma_g^-$) leads to a molecule in the $^3\Sigma_u^-$ state which is excited 3·5 volts above the dissociation limit of this state. For the emission of a band system, recombination to the excited state must occur, and this becomes more probable at high pressures where rapid diffusion is prevented. Results obtained by various

authors using high-voltage arcs, ozonizers and glow discharges all support this result.

These investigations were undertaken in connexion with work in progress here on the spectrum of the night sky, and from the spectra measurements are being made which will enable the O_3 Herzberg bands, believed present in the night sky spectrum, to be more accurately predicted than previously.

I am indebted to Prof. R. W. B. Pearse for suggesting the work and for his constant advice.

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April 16.

[1] Lalji Lal, *Nature*, **161**, 477 (1948).
[2] Wulf, O. R., and Melvin, E. H., *Phys. Rev.*, **55**, 687 (1939).
[3] Flory, P. J., *J. Chem. Phys.*, **4**, 23 (1936).

A Simple Result in Quadrature

In calculating the intensity of light scattered by a transparent homogeneous medium, one comes across the infinite series[1]

$$\alpha \sum_{n=-\infty}^{+\infty} \frac{\sin^3(n\alpha+\theta)}{(n\alpha+\theta)^3}, \qquad (1)$$

in which θ is a constant and n an integer. α is a positive number, which under the conditions under which light-scattering is generally studied is very small, and hence the sum of the above series is usually replaced by the corresponding integral

$$\int_{-\infty}^{+\infty} \frac{\sin^3 x}{x^3}\,dx, \qquad (2)$$

which evidently is equal to π.

It can be shown[1], however, that the equality of (1) and (2) holds not only in the limit when $\alpha \to 0$, but for any value of α in the range $0 < \alpha \leqslant \pi$. An obvious interpretation of this result is that the area subtended between the curve $y = \sin^3 x/x^3$ and the x-axis can be obtained by taking the sum of the ordinates at equal intervals α, $0 < \alpha \leqslant \pi$, and multiplying by α, that is, by simple rectangulation, just as well as by integration. In erecting these ordinates at equal intervals, we may start from any value θ of x.

The main purpose of this note is to direct attention to this property, namely,

$$\alpha \sum_{n=-\infty}^{+\infty} f(n\alpha+\theta) = \alpha \sum_{n=-\infty}^{+\infty} f(n\alpha) = \int_{-\infty}^{+\infty} f(x)\,dx, \qquad (3)$$

where $0 < \alpha \leqslant$ a certain constant α_0, which characterizes $f(x) = \sin^3 x/x^3$, and to show that numerous other functions can be constructed that have this property. A method of evaluating (1) given by Prof. Wiener, and quoted in the paper referred to[1], suggests the criterion by which to construct such functions.

Consider an even function $F(x)$ $[= F(-x)]$ the Fourier transform of which,

$$g(v) = \frac{1}{\sqrt{(2\pi)}} \int_{-\infty}^{+\infty} F(x)\,\exp(ivx)dx, \qquad (4)$$

has non-zero values when $|v|$ is less than a certain constant v_0, and is zero otherwise. Then by Poisson's summation formula[2]

$$\alpha \sum_{n=-\infty}^{+\infty} F(n\alpha+\theta) = \sqrt{(2\pi)} \sum_{N=-\infty}^{+\infty} \exp[-i2\pi N\theta/\alpha]\, g(2\pi N/\alpha), \qquad (5)$$

where n and N are integers and $\alpha > 0$. If now α is chosen to be $\leqslant 2\pi/v_0$, then all the terms on the right-hand side of (5) except the one corresponding to $N = 0$ vanish, and we obtain

$$\alpha \sum_{n=-\infty}^{+\infty} F(n\alpha+\theta) = \sqrt{(2\pi)}\, g(0),$$

which can be seen from (4) to be equal to $\int_{-\infty}^{+\infty} F(x)\,dx$;

and hence the function F satisfies (3).

Since the Fourier integrals of a large number of functions have been tabulated by Campbell and Foster[3] and by others, it is easy to select, or construct, examples of functions F the Fourier transforms of which satisfy the above criterion, and which satisfy (3). $F(x) = \sin^m x/x^n$, where m and n are positive integers, $m \geqslant n$, both of them odd or both of them even, is one such function with $v_0 = m$; when $m = 1$, the range of v over which $g(v) \neq 0$ includes $v = 1$. A few other examples are given below.

$F(x)$	$\sqrt{(2\pi)} \cdot g(v)$	v_0
$\dfrac{\sin[a(x^2+\lambda^2)^{1/2}]}{(x^2+\lambda^2)^{1/2}}$	$\pi J_0[\lambda(a^2-v^2)^{1/2}]$	a
$\cos[a(x^2+\lambda^2)^{1/2}] - \cos ax$	$-\dfrac{\pi a\lambda J_1[\lambda(a^2-v^2)^{1/2}]}{(a^2-v^2)^{1/2}}$	a
$\dfrac{1}{\Gamma(\alpha+x)\,\Gamma(\beta-x)}$	$\dfrac{(2\cos 1/2v)^{\alpha+\beta-2}\{-\frac{1}{2}\exp iv(\alpha-\beta)\}}{\Gamma(\alpha+\beta-1)}$	π [4]

A more detailed account will be published shortly in the *Journal of the Indian Mathematical Society*.

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Delhi. June 6.

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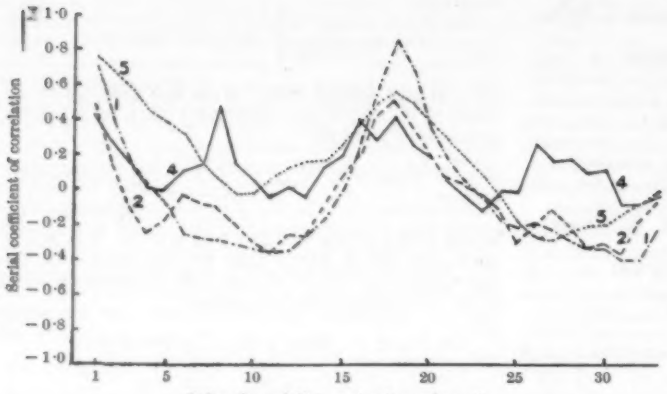
Physical Periodicity of the Periodic Table of the Elements in the Light of Statistical Theory

The periodic system of the elements, arrived at originally from the collation of facts of a chemical nature, has since been most strikingly reflected by most of the physical properties of the elements. The melting points, boiling points, coefficients of thermal expansion, atomic volumes, compressibilities, densities, ionization potentials, to mention only a few properties, undergo periodic variations with increasing atomic weight or atomic number.



1, Atomic volumes; 2, melting points; 4, ionization potentials; 5, densities

It seemed of interest to inquire whether the generating mechanism of the physical periodicity was the same for all the physical properties to which it applied, or whether there existed characteristic differences between the periodicities of different physical properties. With the view of obtaining an answer to that question, some of the series were subjected to the statistical analysis called correlogram analysis[1]. The correlogram is the plot of the serial correlation coefficient against the order of correlation. For example, in the correlogram for atomic volume, the points are the correlation coefficients between the series of atomic volumes 1, 2, 3 . . . n times apart in the series of the elements arranged according to their atomic numbers, plotted against the atomic number minus one.

The series subjected to the analysis were those of the atomic volumes (1), melting points (2), compressibilities (3), ionization potentials (4) and densities (5) of the first sixty elements. Series 1 to 4 are based upon Tables 2 and 16, Chapter 5 of "Physical Chemistry" by E. A. Moelwyn-Hughes; Series 5 is taken from Table 3, "Physical Chemistry" by Gucker-Meldrum, based upon the International Critical Tables, supplemented by Landolt – Börnstein tables. The first thirty-three serial correlation coefficients were calculated and plotted against the order of correlation; the curve for compressibilities has been left out of the diagram so as to avoid overcrowding.

On the basis of the correlogram it appears that what was hitherto called 'physical periodicity' has a different structure, that is, it represents sums of different cyclical components, for each of the physical characteristics under investigation. So far as the correlograms show similarities, it would seem that they can be classified into two types. The correlograms for atomic volumes, densities and compressibilities show a peak for the correlation of order 18, and a trough for that of order 10 or very near it, which corresponds to the elements 19 (potassium) and 11 (sodium) respectively, and thus reveal a period of length 18, which corresponds to twice the fundamental period of the chemical periodicity of 8, plus the first two elements of the table. The correlograms for melting points and ionization potentials, on the other hand, show, in addition to the period of length 18 (16), a smaller one with peaks at 8 and 26, or very near them, and thus a greater similarity to the chemical periodicity of the elements with its fundamental period of 8.

Since the melting points (the temperature at which the atoms begin to leave the crystal lattice) and ionization potentials (the energy needed for removing an electron from the atom) have this in common, that they both refer to the point where lattice disorder sets in, and thus to the *dynamic* properties of matter, whereas atomic volumes, densities and compressibilities are properties of the *static* atom, it would seem that this difference is faithfully portrayed in the respective types of physical periodicity as revealed by the correlogram.

Investigations of this kind may afford an indication for linking more intimately than has been done so far the mechanism of the various physical periodicities with the periodic system of the electrons constituting the shells and subshells of the atom.

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X-Ray Scattering by Thermal Vibrations in Crystals

SIR C. V. RAMAN, in his letter on "X-Rays and the Eigen-Vibrations of Crystal Structure"[1], claims that the elastic vibrations cannot "give rise to any geometric diffraction pattern exhibiting an observable relationship to the structure of the crystal". The reasons given for this statement make it appear that he has fallen into Debye's original error, and supposes that the atomic vibrations are essentially independent, or are markedly dependent on the form of the crystal and on external boundary conditions. This would perhaps be the case for very small crystallites; for crystals of ordinary size the boundary conditions would involve second-order effects only, as they do in the case of Bragg reflexion. It should also be clearly understood that the change of frequency due to the X-ray 'Doppler effect' is so small that the modified wave-lengths still lie well within the width of the monochromatized $K\alpha_1$ line, assuming that to be the incident radiation; the change is of the order of 1 in 10^5.

That the elastic vibrations do indeed give rise to a geometric diffraction pattern has been most conclusively proved by the excellent agreement between theory and experiment for metals such as sodium, lead and tungsten. The theory of eigen-vibrations can offer no explanation whatever of these experimental results, whereas the elastic vibration theory predicts them correctly in every detail[2].

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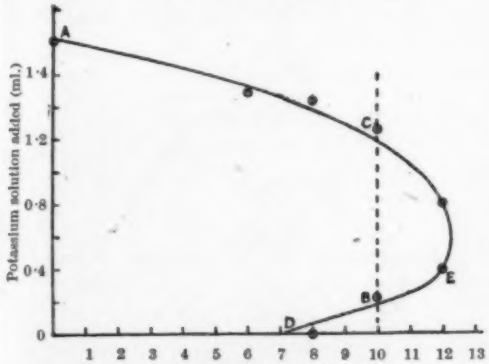
Interaction between Curare and the Potassium Ion at the Motor End Plate

In a previous paper[1] evidence was presented that there is a relation between the curariform activity of an onium ion and the charge density on its quaternary central atom. A consideration of this theory and of the fact that the paralysing action of curare can be reversed by a fall of temperature[2] led to an investigation of the antagonism between curare and the potassium ion[3].

By working below 30° C., it has been possible to study the actions on the rat diaphragm[4] of potassium ion concentrations which reduced neuromuscular transmission while leaving the muscle fibres fully responsive to direct electrical stimulation. Under these conditions, it was possible to demonstrate a neuromuscular block by high concentrations of the potassium ion alone (point *A* on graph). This block may be similar to that produced in ganglia by high doses of potassium chloride[5]. The graph also shows that by bringing the muscle into equilibrium with increasing concentrations of curare it has been possible to demonstrate that the addition of curare reduces the concentration of potassium required to cause a 50 per cent block. When the dose of curare which causes a 50 per cent block at normal concentrations of potassium ions is exceeded, the addition of potassium ion has two opposite actions (dotted line). First it antagonizes and decreases the block, the point *B* giving the potassium ion concentration which produces a 50 per cent block, and then after reducing the block still further a point is reached when more potassium sums with the curare and causes the block to increase again. The point *C* represents the 50 per cent block produced by adding excess potassium ions. The line *D*—*E* corresponds to the potassium ion – curare antagonism observed earlier[3].



Relationship between *d*-tubocurarine chloride added to a 40 ml. bath and the amount of Tyrode solution containing 100 times the normal amount of potassium chloride required to maintain the neuro-muscular conduction of the preparation in a state of 50 per cent block

It appears to us that the interaction between curare and the potassium ion is an ion exchange reaction (cf. ref. 6 in this connexion), and that the region of the motor end-plate contains an ion exchanger. Moreover, we would like to suggest that in normal neuromuscular transmission the onium ion group of acetylcholine liberated by the nerve impulse reacts with the exchanger, to which potassium ions are normally bound, and that the potassium ions so displaced stimulate the muscle fibre, possibly by depolarizing it. The liberation of acetylcholine ions and their displacement of potassium ions from the ion exchanger would give rise to potentials of the liquid junction type. Moreover, the depolarization of the muscle fibre by the potassium ions would set up electrotonic and action potentials. The complexity of end-plate potentials[7,8] is therefore not unexpected. The marked similarity between the actions of potassium and acetylcholine[9] becomes easy to understand; and the continued occupation of the receptors of the ion exchanger by curare, stable choline esters and acetylcholine after eserine[10], by preventing the re-occupation of those receptors by potassium ions in preparation for the next impulse, explains the blocking action of these substances. We can represent the reaction between the receptors of the exchanger and the potassium ion briefly as follows:

$$R^- + K^+ \rightleftharpoons RK.$$

Normally, the acetylcholine liberated by a nerve impulse, by combining with free receptors and blocking the left to right part of the equilibrium, would leave the dissociation of potassium ions unopposed, with a consequent local rise in potassium concentration at the muscle fibre. If we decrease the free receptors by raising the potassium ion concentration, then acetylcholine cannot combine; hence the blocking action of excess potassium and its summation with curare when the number of free receptors is the limiting factor. Curare acting on normal muscle would decrease that potassium bound to the receptor which is available for exchange with acetylcholine. In this case, potassium ions would antagonize curare by increasing the available bound potassium.

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Effect of Drugs on Actin

In previous work from this laboratory it has been established that the polymerization of actin is influenced by various ions in different ways. In view of the possibility that the change of globular actin into fibrous actin plays an important part in the mechanism of muscle contraction, it is especially interesting that calcium and potassium (or sodium) ions show antagonistic action at some concentrations[1].

When globular actin polymerizes, the reaction-rate can be followed by the rising viscosity of the solution. The reaction is usually of an autocatalytic type; therefore the rate is best measured by the reciprocal value of the time needed to reach 50 per cent polymerization. Such a study, using 0·001 *M* calcium chloride and varying concentration of potassium

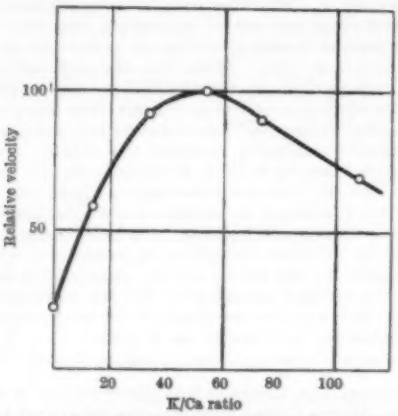

Fig. 1. Variation in the rate of polymerization of actin in presence of calcium (0·0005–0·001 *M*) and potassium (0–0·11 *M*) ions

chloride (*p*H 7) at 24° C., gave the results represented in Fig. 1. As the rate of polymerization of a given actin preparation is variable, the results are represented as a percentage of the rate obtained at the physiological potassium – calcium ratio. It is seen that in this type of experiment a synergistic action of calcium and potassium is observed, with an optimum at the physiological ratio.

The effect of many of the drugs which act directly on muscle is analogous, and is supposed to be related, to the action of one or other of the cations of the tissue. It was therefore of interest to study the effect of such drugs on the ion-catalysed reaction of the polymerization of actin. We have found that the rate of polymerization was greatly enhanced by adrenaline (0·1 mgm./ml.), whereas it was inhibited in presence of the same concentration of quinine, strychnine and veratrine. The study of these effects at varying potassium – calcium ratios gave the very suggestive curves of Figs. 2 and 3. In both these figures the ordinate represents percentage change in the rate of polymerization when compared with a control experiment in which actin was polymerized in presence of the same ions but without the addition of the drug.

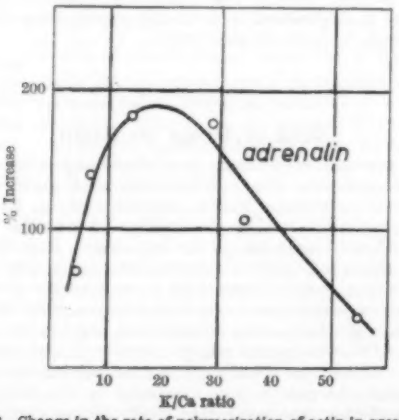

Fig. 2. Change in the rate of polymerization of actin in presence of adrenaline (0·1 mgm. per ml.) in relation to the rate of polymerization in presence of the same salt concentration but in absence of drug

A purified concentrate of the prosthetic group of actin (0·1 mgm./ml.) gave rise to effects similar to that of adrenaline.

Different preparations of actin are influenced by the above-mentioned drugs to a varying degree even at constant ionic environment. This lends further support to the conception advanced in an earlier paper[1] that the process of polymerization is a series of reactions, any one of which might be the limiting factor in a given preparation. One of these reactions can be catalysed either by the prosthetic group of actin or by calcium and adrenaline.

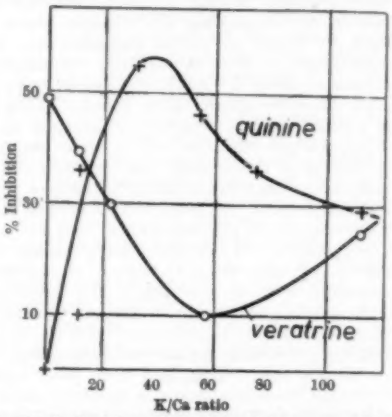

Fig. 3. Effect of quinine and veratrine (0·1 mgm. per ml.) on the polymerization of actin under the same conditions as for Fig. 2

The present results make it very probable that the molecular changes of actin are involved in the contraction mechanism.

A detailed account of this work will appear in the *Hungarica Acta Physiologica*.

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Actomyosin Content of the Uterus

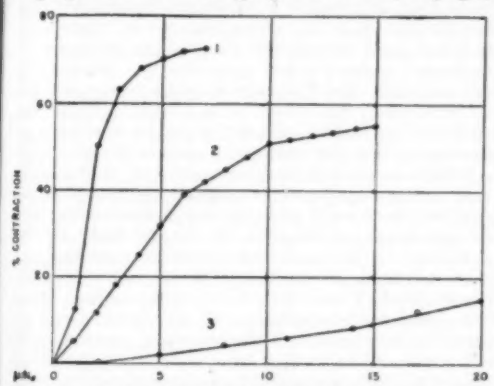
The methods developed by the Szent-Györgyi school[1] offer a possibility of characterizing and explaining the well-known differences which exist between the pregnant and the non-pregnant uterus. I have applied these methods to the study of human and animal uteri under normal conditions, in different stages of pregnancy and in certain pathological cases.

The actomyosin of the frozen uterus was extracted with 3 volumes 0·5 mol. potassium chloride, in the presence of 2·5 mgm./gm. muscle adenosine triphosphate, by thoroughly grinding it with sand. The viscosity of the actomyosin solutions with and without the addition of adenosine triphosphate, and the contraction of the actomyosin thread in the presence of adenosine triphosphate, were measured. Both methods show that the extracted material is a mixture of actomyosin and myosin. The data in the accompanying table were obtained from viscosity determinations calculated according to Szent-Györgyi and Straub[2,3].

Material	Amounts of actomyosin and myosin in the solution extracted from 1 gm. material		
	Mixture	Myosin	Actomyosin
Non-pregnant human uterus	16	11	5
Human uterus during labour (Cæsarean sect.)	22	9	13
Human cross-striated muscle	44	18	26

The absolute and relative actomyosin content of the non-pregnant uterus extracts is much lower than that of cross-striated muscle, and increases with advancing pregnancy, rapidly reaching its maximum immediately before parturition.

The contraction of a thread of actomyosin, followed in time, clearly demonstrates the differences between the pregnant and the non-pregnant uterus (see graph).



Contraction of actomyosin threads prepared from human uteri: (1) during labour; (2) from non-pregnant uteri; (3) from uteri after X-ray castration

These observations seem to explain many problems in the physiology and even pathology of gravidity and parturition (abortion at too high, and very weak labour at too low, concentrations of actomyosin ?).

More work is planned along this line, and a detailed report will appear elsewhere.

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Production of Riboflavin and Allied Substances during the Growth of *C. diphtheriæ*

While studying, by paper partition chromatography[1], the utilization of amino-acids during the growth of the Park Williams No. 8 strain of *C. diphtheriæ*, we noted a strong yellow fluorescence with ultra-violet light of culture filtrates of the organism grown on a casein hydrolysate medium prepared essentially according to the method of Mueller and Miller[2]. When such culture filtrates were run on chromatograms using *n*-butanol-acetic acid as the solvent[3], two strongly fluorescent yellow spots were observed when the dried paper was placed under an ultra-violet lamp. Neither of these spots gave any colour when the paper was sprayed with 0·1 per cent (w./v.) ninhydrin in chloroform. One of them was in a position approximating to that occupied by proline and the other to that occupied by the basic amino-acids.

It was suggested to us by Dr. W. A. Rawlinson that these fluorescing spots might be due to flavins, and we have since learned that Wadsworth and Crowe[4] have shown that a special strain of *C. diphtheriæ*, grown on a synthetic medium, elaborated an unidentified flavin. We found that the faster moving spot had the same R_f value as riboflavin when run with either *n*-butanol-acetic acid or collidine as solvent. Moreover, when these spots were eluted from the chromatogram, both showed riboflavin activity, as did the original culture filtrate, when examined by the usual microbiological technique using *Lactobacillus casei* E. as the test organism. The crude culture filtrate had an activity equivalent to 25 μgm. of riboflavin per ml.

We found, also, that the fluorescent material behaved chemically like riboflavin. It was resistant to the action of potassium permanganate and hydrogen peroxide, would pass through a 'Cellophane' bag, and could be adsorbed on Fuller's earth and 'Super-filtrol', from which it could be eluted with small volumes of 20 per cent (v./v.) pyridine in 2 per cent (v./v.) acetic acid solution. Such an eluate when chromatographed gave two fluorescent spots, in the same position but much more intense than those on the chromatogram of the original culture filtrate. The eluate, when evaporated to dryness and taken up in water, once again showed riboflavin activity when tested by microbiological assay methods.

Therefore there is strong presumptive evidence that the faster moving of the two fluorescent spots obtained on chromatograms of culture filtrates of the Park Williams No. 8 strain of the diphtheria bacillus is riboflavin itself, while the other may possibly be either riboflavin phosphate or flavine adenine dinucleotide, both of which have been reported by Crammer[5] as having R_f values approximating to that obtained by us for this slower moving spot.

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Sex and Organ Specificity in the Response of β-Glucuronidase to Extrinsic Agents

It was considered that the correlation shown to exist between the β-glucuronidase activity of a tissue and the amount of cell proliferation in progress[1] could explain the rise in uterine glucuronidase found by Fishman and Fishman[2] to follow œstrogen administration to ovariectomized mice. In a preliminary kinetic study of the enzyme in mouse uterus, the *p*H-activity curve for the hydrolysis of phenol β-*d*-glucuronide was found to be almost symmetrical about *p*H 4·5. This is in contrast to the curves

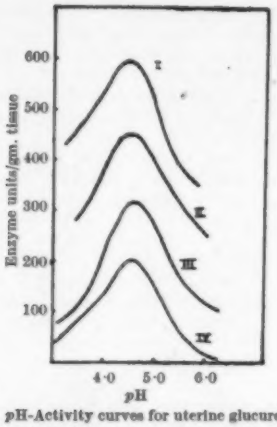

Fig. 1. *p*H-Activity curves for uterine glucuronidase

I, 10-day old mice; II, ovariectomized adults, 3 days after subcutaneous injection of 50 μgm. œstrone; III, normal adult; IV, ovariectomized adults

previously found for liver and spleen glucuronidase in the normal mouse[2], with peaks at *p*H 5·2 as well as at 4·5. Mills[4] has shown that beef spleen glucuronidase can be separated into two fractions, *A* and *B*, with slightly different *p*H optima for the hydrolysis of menthol glucuronide. Since it seemed probable that mouse uterus lacked a glucuronidase fraction present in liver and spleen, it was considered necessary to investigate the possibility that differences between *A* and *B* in distribution and response to extrinsic agents might in some way explain the selective actions of such substances as carbon tetrachloride and œstrone on liver and uterine tissue respectively.

As can be seen from Figs. 1 and 2, the *p*H activity curves for liver and uterine glucuronidase were unchanged in shape during active growth. The high figure for uterine glucuronidase in infant mice supports the view that in this organ, as in others, the activity of the enzyme is a measure of cell division. The effect of carbon tetrachloride on liver does not suggest any selection between the glucuronidase fractions. Carbon tetrachloride is known to have no effect on kidney glucuronidase[5], in spite of the fact that the *p*H activity curve has been found to have the same general shape as that shown for liver.

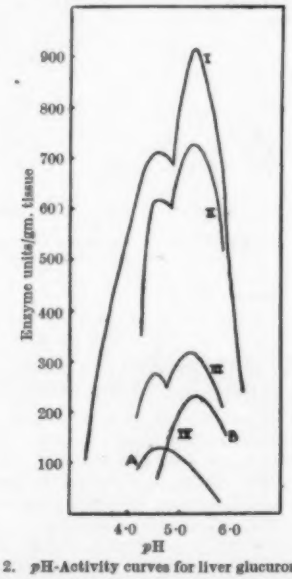

Fig. 2. *p*H-Activity curves for liver glucuronidase.

I, 6-day old mice; II, adult, 1 day after subcutaneous injection of 5 gm. chloroform/kgm.; III, normal adult; IV, the same preparation as III after separation of *A* and *B*

In further experiments, fraction *A* was precipitated by making the preparation 38·5 per cent saturated with ammonium sulphate[4] at *p*H 5·2, and the two fractions were then determined separately. All uterine enzyme was found in fraction *A*. The separation achieved is illustrated for a liver preparation in Fig. 2. In the response of liver glucuronidase to chloroform, and kidney to mercuric nitrate, *A* and *B* were equally affected. Eschenbrenner and Miller[6] found the production of renal necrosis in mice by chloroform, seen only in males, to be prevented by castration, and noted a correlation between kidney morphology and its susceptibility to chloroform. Morphological differences were confined mainly to Bowman's capsule; but this was not involved in the necrosis. The response of kidney glucuronidase to chloroform observed in the male mouse[5] was abolished by castration. While figures for untreated females, males and castrated males did not suggest any differences in *A* or *B* corresponding to the variations in the structure of the kidney, the rise in kidney glucuronidase after injection of normal males with chloroform was confined to fraction *B*. This could be explained on the assumption that the two glucuronidase fractions are unevenly distributed throughout the kidney. From the other results quoted above, it appears that the response by glucuronidase to any agent is independent of the 'fraction' present in the cell affected. For the comparative study of the effects of extrinsic agents on organs such as liver and kidney, it would appear adequate to determine the total enzyme activity at *p*H 5·2. The importance of determining the *p*H-activity curve for each new organ examined is, however, emphasized by the findings for the uterus.

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Aneurin-Pyrophosphate Content of Red and White Blood Corpuscles in the Rat and in Man

WE have determined accurately the aneurin-pyrophosphate content of red and white blood corpuscles in the rat and in man. Rats in a well-nourished condition and with slight aneurin deficiency were examined, and also human subjects, both healthy and suffering from various diseases. Determinations were carried out in two blood fractions, obtained by centrifuging, one containing a large number of red cells and very few white cells, the second containing practically all the leucocytes of the blood

sample and relatively few erythrocytes. Centrifuging must be carried out at a low rate, as at high rates the white cells agglutinate and cannot be resuspended for counting. Cell counting[1] must be performed with great care, as it is subject to much larger errors than the aneurin-pyrophosphate determination. The latter was carried out according to Westenbrink *et al.*[2].

Working with seven well-nourished male albino rats, their red cells contained $2{\cdot}1 \pm 0{\cdot}41\ \gamma$ aneurin-pyrophosphate per 10^{11} cells, the white cells $340 \pm 100\ \gamma$ per 10^{11} cells; so the average rat leucocyte contains about 160 times as much as an erythrocyte.

For eight normal men the average red cell content was $1{\cdot}49 \pm 0{\cdot}08\ \gamma$ aneurin-pyrophosphate per 10^{11} cells; for fourteen normal women the average was $1{\cdot}28 \pm 0{\cdot}09\ \gamma$ per 10^{11} cells. This sex difference was significant. Such a difference was not found for the white cells, their average content being $280 \pm 45\ \gamma$ per 10^{11} cells. So for human beings the ratio of the contents of a red and a white cell is about 1 : 200.

Although the aneurin-pyrophosphate content of erythrocytes is low, they contribute most to the aneurin-pyrophosphate of total blood, owing to their very large number.

A ration containing less than $0{\cdot}15\ \gamma$ aneurin a day (a rat needs about $10\ \gamma$ a day) caused a significant decrease of the aneurin-pyrophosphate content of rat erythrocytes from $2{\cdot}1 \pm 0{\cdot}41\ \gamma$ to $1{\cdot}0 \pm 0{\cdot}19\ \gamma$ per 10^{11} cells in five days; the decrease of the leucocyte content was much less pronounced and only just significant, namely, from $340 \pm 100\ \gamma$ to $240 \pm 58\ \gamma$ per 10^{11} cells. The decrease of the red cell content in the avitaminotic rats runs roughly parallel to the decrease in liver, kidney and muscle, while the decrease of the white cell content is roughly proportional to that of the brain. This shows that differential determination of the aneurin-pyrophosphate content of the blood corpuscles provides conclusive information regarding the aneurin-level of the body.

When seven human subjects (six men and one woman) received an aneurin-poor diet for ten days, the average aneurin-pyrophosphate content of the red cells had decreased to about $1{\cdot}15 \pm 0{\cdot}08\ \gamma$ per 10^{11} cells, while the decrease of the white cell content, though distinct, was less pronounced. Human blood cells thus appear to be slower in losing their aneurin-pyrophosphate than rat cells.

In two cases where abnormally high values for the red cell content were found in apparently healthy subjects, this appeared to be due to the abnormally large volume of their erythrocytes, the aneurin-pyrophosphate content being normal when reduced to normal cell volume.

The aneurin pyrophosphate content of the red cells also appeared to depend upon their age; in the nucleated stage they may contain as much as $100\text{–}160\ \gamma$ per 10^{11} cells.

In general, our work on pathological subjects, comprising cases of pernicious anæmia, primary liver carcinoma with extensive hæmorrhagia, erythroblastosis, lymphatic leucæmia, pyloris stenosis, myeloid leucæmia, and of aneurin deficiency, has shown that conclusions regarding the aneurin-level of the body cannot be based upon aneurin-pyrophosphate determination in total blood only. A blood count must always be made and the blood picture studied; for a reduced number of red cells can depress heavily the total content of blood even while the content of each cell may be normal or even increased. Conversely, in a case of leucæmia with a total blood content of $210\ \gamma$ per 100 cm.^{3} (normal: $\pm 8\ \gamma$ per 100 cm.^{3}), this very high value was caused by the extremely large number of white cells.

A full account of our experiments and discussion of the accuracy of the results will appear in *Biochimica et Biophysica Acta*.

This work forms part of investigations on aneurin metabolism being carried out by Prof. H. G. K. Westenbrink and collaborators.

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A Hyaluronidase Unit

Despite our deficient knowledge of the physical and chemical properties of both hyaluronic acid and hyaluronidase, it seems desirable to have a hyaluronidase unit, which can be used until international standard preparations are available for comparison, in order to be able to correlate the numerous investigations being carried out with this substance. All investigations so far suggest that the viscosimetric method of estimation at present affords the best possibilities for quantitative analysis of a biological material.

By a series of investigations into the individual phases of the viscosimetric estimation, we have obtained a unit for hyaluronidase. We define this unit as the amount of enzyme which at 37° C. in the course of 300 sec., by its action on 1 litre of a solution of roughly purified hyaluronic acid from synovia of recently killed cattle with a time of flow in a special viscosimeter of about 2·5 times that for water, reduces the increase in time of flow due to hyaluronic acid to half that period. We find it more important at present that the conception of a unit should be attached to an easily accessible hyaluronic acid preparation and a viscosimeter of fixed dimensions than to provisional local standard preparations of the enzyme.

The hyaluronic acid preparation applied is prepared from synovial fluid produced by puncture of the hock of cattle immediately after killing. The synovial fluid is diluted with an equal part of distilled water, after which the hyaluronic acid is precipitated by addition by drops of glacial acetic acid. The resulting coagulum is washed with distilled water and dissolved in phosphate citric acid buffer $M/60$, pH 7·0 (after McIlvaine) with 3·5 per mille sodium chloride. The solution is adjusted to a relative viscosity of about 3 and pH 6 by addition of buffer and 4 N sodium hydroxide.

The viscosimeter used is U-shaped with a wide tube of internal diameter 6 mm. and a capillary tube of internal diameter 0·3–0·4 mm., forming the bend and the measurement section. On this latter is a broadened region with a volume of 0·2 ml., delimited above and below by scratch marks. The distance from the lower mark to the bend is 175 mm.

A further account of the procedure of analysis pertaining to a viscosimetric rapid method will be published in the *Acta pharmacol. et toxicol.* (Copenhagen).

Since devising this method, we have been able to examine a sample of hyaluronidase from the Treemond Company, Brooklyn, N.Y. This sample was declared to contain 100 turbidity-reducing units per mgm.; by our method this was found to be equal to 2 hyaluronidase units as defined above. We therefore expect the ratio of the turbidity-reducing unit to our hyaluronidase unit to be approximately 50.

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Indicator Yellow and Retinene$_1$

In their interesting article on the "Chemistry of Visual Processes", Ball, Collins, Morton and Stubbs[1] consider that Lythgoe's indicator yellow[2] is a "fortuitous artefact having no direct relevance to visual chemistry". They base this conclusion on the fact that retinene$_1$ may be extracted from bleached retinæ or from bleached visual purple (rhodopsin) solutions by a mixture of acetone, ethanol and light petroleum ether and that "free or loosely bound retinene$_1$ (the final product of bleaching rhodopsin) may combine with any suitable protein or amino-acid which may be available". They regard this fortuitous combination as the means of production of indicator yellow in solution.

These facts do not, however, justify their conclusion. Lythgoe[2] was unable to extract retinene from bleached visual purple solutions using petroleum ether alone as solvent. Hecht[3] has pointed out that alcohol must be added to the petroleum ether in order to extract the retinene. Again, if cold acetone is added to a bleached visual purple solution, the precipitate "contains not only the protein but most of the yellow colour. The retinene must therefore still be mainly attached to the protein, since carotenoids are not easily adsorbed in the presence of high concentrations of acetone" (Hecht, *ibid.*).

The inference is plainly that, after bleaching, the altered visual purple chromophores are still attached to the parent protein (this arrangement constituting the indicator yellow molecule), unless an active reagent such as alcohol strips these altered chromophores (retinene) from the protein. Thus by using alcohol, or other active agent, in the solvent, one is extracting a substance retinene, which is *not*, in fact, "the final product of bleaching rhodopsin". The recombination of retinene with a suitable protein (perhaps, indeed, the original protein from which it was detached) to yield 'indicator yellow' could then scarcely be described as 'fortuitous' but rather the restitution of the original state of affairs.

The visual purple molecule consists of a protein 'base' to which are attached about ten chromophores[4]. It is known that when one quantum of light is absorbed one chromophore is altered[5], but there is no evidence for the statement, often occurring in the literature, that the secondary process following activation of the chromophore is a loosening, that is, a dissociation of the chromophore-protein bond. It is just as probable that activation of a visual purple chromophore by a light quantum is succeeded by a chemical process resulting in an electron transfer down the conjugated carotenoid chain to the protein base and thence, *in vivo*, to the retinal end-organ to which, in all probability, the visual purple molecules are attached. This gives us a simpler picture of the genesis of the physiological impulse than does the usual view that the retinal end-organs are stimulated by a product of the disrupted visual purple molecule.

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[5] Dartnall, H. J. A., Goodeve, C. F., and Lythgoe, R. J., *Proc. Roy. Soc.*, A, **156**, 158 (1936); A, **164**, 216 (1938).

The facts quoted by Dr. Dartnall do not invalidate our conclusions. If under the action of light the retinene is split off, the conditions are such that it is available for recombination with any protein to form new compounds. The spectroscopic evidence indicates that there are three materials in bleached rhodopsin solutions, retinene (or retinene + protein) and the acid and alkaline forms of indicator yellow. We consider that, although the same protein is concerned in all three compounds, yet the chemical evidence indicates that in indicator yellow, retinene is firmly bound while in neutral bleached rhodopsin solutions it is only weakly bound. We agree with Dr. Dartnall's final paragraph.

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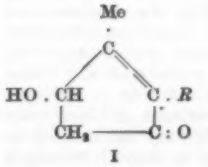
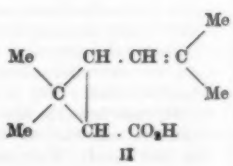
Total Synthesis of some Pyrethrins

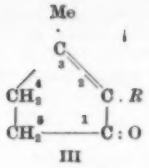
In view of recent publications in the United States, it is desirable to record briefly some of the results obtained by us during the past year or so. Following the demonstration by LaForge and Barthel[1] of the heterogeneity of 'pyrethrolone', the alcoholic component of the pyrethrins, and the revision by LaForge and Soloway[2] of the structures of the constituent alcohols to (I), where *R* is butenyl or pentadienyl, and the synthesis by Campbell and Harper[3] of (−)-*trans*-chrysanthemum monocarboxylic acid (II), the enantiomorph of the acidic component of pyrethrin I, the total synthesis of various pyrethrins (that is, esters of I with II), the insecticidal constituents of pyrethrum flowers, appeared a more favourable project than previously.



I



II



III

A convenient route to ketones of type (III) was explored by Harper[4], by the preparation of ketones, in which R = *n*-butyl and butenyl, the former being identical with dihydrocinerone and the latter isomers of cinerone; and has since been extended to higher analogues, in which R = *n*-amyl, pentenyl, etc. If direct substitution could be effected in position 4, then subsequent condensation with chrysanthemum monocarboxylic acid would provide a convenient route to pyrethrins, in which structural and stereochemical variations could be readily made. The 4-position is analogous both to the γ-position of crotonaldehyde and crotonic esters and to the β-position of saturated esters, and might therefore be expected to undergo free radical substitution more readily than elsewhere. Developing this approach, we have been able to effect smooth substitution of bromine, using N-bromosuccinimide in carbon tetrachloride, to give what we believe to be the 4-bromoketone, though we have not yet established this unequivocally. Nevertheless, reaction with silver acetate in glacial acetic acid gives the corresponding acetoxyketone, which is saponified to the hydroxyketone, of the same series, irrespective of the absolute structure, as natural pyrethrolone and cinerolone. When R is *n*-butyl, the product is (±)-dihydrocinerolone, which has also been synthesized by a similar method by Sôloway and LaForge[5]; and when R is *n*-amyl, the product is (±)-tetrahydropyrethrolone, which has also been synthesized by a similar method by Dauben and Wenkert[6] (see Table 1).

Table 1

	(I), R = *n*-Butyl	Dihydrocinerolone	Ref.
Alcohol	b.p. 114–117°/0·8 mm.	(+) 115–117°/1 mm.	1
	n_D 1·4946 (19°)	(+) 1·4958 (22°)	1
Semicarbazone	m.p. 184–185°	(±) 185°, 184–185°	1, 8
3:5-Dinitrobenzoate	m.p. 110–110·5°	(±) 111°	5
Acetate	b.p. 100–103°/0·75 mm. 97°/0·25 mm.		
	n_D 1·4788 (20°) 1·4772 (20°)		
Acetate 2:4-dinitrophenylhydrazone	m.p. 125–126°		

	(I), R = *n*-Amyl	Tetrahydropyrethrolone]	
Alcohol	b.p. 127°/0·4 mm.	(+) 124°/0·6 mm.	9
	n_D 1·4882 (25°)	(±) 1·4892 (28°)	1
Semicarbazone	m.p. 169°	(±) 172–173°, 172–174°	1, 8
3:5-Dinitrobenzoate	m.p. 105–106°		
Acetate	b.p. 103°/0·4 mm.	(+) 117°/1·3 mm.	9
	n_D 1·4747 (25°)	(+) 1·4761 (20°)	9

Having established the relationship of these products to the pyrethrins, we have now submitted the bromoketone in carbon tetrachloride to reaction with the silver salt of synthetic chrysanthemum monocarboxylic acid and isolated by distillation the corresponding pyrethrin. Table 2 lists the synthetic esters we have obtained, and their stereochemistry. These esters have been tested for insecticidal properties, and are of a low order, thereby confirming the low toxicity reported by LaForge and Barthel[7] for tetrahydropyrethrin I.

Table 2

(I), R =	Stereochemistry of alcohol	Stereochemistry of acid	B.p.	n_D^{25}
n-Butyl	(±)	(±)-*trans*	115–116°/1 × 10^{-2} mm.	1·4992
n-Butyl	(±)	(±)-*cis*	117–119°/3 × 10^{-4} mm.	1·5000
n-Amyl	(±)	(±)-*trans*	96°/7·8 × 10^{-4} mm.	1·4970
n-Amyl	(±)	(±)-*cis*	120–124°/2·1 × 10^{-3} mm.	1·4980

Experiments are in progress to establish beyond doubt the position of substitution and to investigate the extension of this method to ketones in which R = butenyl, pentenyl, etc.

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April 13.

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[4] *J. Chem. Soc.*, 892 (1946).
[5] *J. Amer. Chem. Soc.*, **69**, 979 (1947).
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[8] West, *J. Chem. Soc.*, 463 (1946).
[9] West, *J. Chem. Soc.*, 412 (1945).

Alkaloids of the Australian Rutaceæ

In certain tribes of the family Rutaceæ a relatively high proportion of species has been found to contain alkaloids. Moreover, these alkaloids vary widely in character and include representatives of several of the principal structural groups, for example, quinoline, *iso*-quinoline, carboline and imidazole derivatives.

We are examining the alkaloids of a number of Rutaceous genera of the Australian flora, particularly those of the Queensland tropical rain-forest. This work is part of a general survey of the occurrence and pharmacology of alkaloids in the Australian flora, which is being undertaken by the Council for Scientific and Industrial Research in collaboration with the departments of chemistry and physiology of several Australian universities. At least six unrecorded alkaloids have been isolated from the three rain-forest species, *Melicope fareana* F. Muell., *Evodia xanthoxyloides* F. Muell., and *Acronychia baueri* Schott. Of these, five are certainly related and exhibit a number of novel features. The bark of *Melicope fareana* contains melicopine ($C_{17}H_{18}O_5N$, pale yellow needles, m.p. 178·5–179·5°), melicopidine ($C_{17}H_{18}O_4N$, pale yellow prisms, m.p. 121–122°), melicopicine (yellow prisms, m.p. 131–132°), and acronycidine ($C_{18}H_{18}O_5N$, colourless needles, m.p. 136·5–137·5°). The leaves of this tree also contain melicopine, melicopidine and melicopicine, but acronycidine is absent. There is present, however, a small amount of another colourless alkaloid which has not yet been obtained in a pure form. The bark of *Acronychia baueri* contains acronycine ($C_{20}H_{19}O_2N$, pale yellow needles, m.p. 174–175°), melicopine, melicopidine and acronycidine, while melicopicine has been isolated from the leaves. The bark of *Evodia xanthoxyloides* contains evoxanthine ($C_{18}H_{13}O_4N$, pale yellow needles, m.p. 217–218°), and melicopidine.

Although the structural problems have not yet been completely clarified, it has been established that the five yellow alkaloids are acridine derivatives, actually N-methyl acridones. Acronycidine (colourless) is probably a quinoline derivative related to skimmianine. A number of other species belonging to the same and related genera are under examination, and it is hoped to correlate the nature of the alkaloids with the taxonomy of the groups concerned. Full details of this work will be published elsewhere.

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Determination of Mixing of Gas Streams by the Infra-Red Gas Analyser

A technique developed by this laboratory for use in model experiments on the mixing of air and gas in the open hearth furnace has application to any problem of turbulent diffusion between streams of similar gases, in which mean concentrations of one gas in the other are to be sampled. The method used combines high sensitivity and rapidity of response with freedom from poisonous tracer substances.

The technique is at present being applied to the study of mixing in a model of a producer gas-fired open hearth furnace. Both air and fuel gas are replaced in the model by air at room temperature, and the pattern of mixing between the air from the gas port and that from the air ports is studied. This pattern is of great importance in furnace design as it determines shape of the flame and rate of burning. To obtain Reynold's similarity with a 1/12-scale model a flow rate of nearly 7 cubic metres/minute is needed, which necessitates a highly sensitive detector if the flow-rate of the tracer is to be kept low.

Originally, consideration was given to the use of a radioactive tracer such as radon, which has already been used both for full-scale furnace experiments and in the laboratory[1,2]; but the commercial production[3] of the infra-red gas analyser provides a means of obtaining sensitivity without the inconvenience of a tracer which decays with time. Using carbon dioxide, a full-scale deflexion is obtained with a concentration of 0·03 per cent, corresponding to a flow of 2 litres/minute, of pure carbon dioxide. In a well-ventilated laboratory, this may be safely run to waste. At the rate of aspiration used, the speed of response of the instrument, including delays introduced in the tubing, is better than 5 sec. for two-thirds final reading.

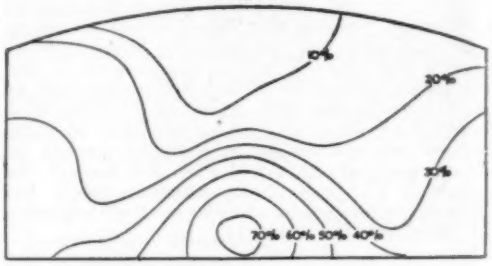
Precautions are necessary to eliminate the effect of changes in the concentration of carbon dioxide in the atmosphere. It has been suggested that the use of methane as a tracer would avoid this. The infra-red gas analyser can be made almost as sensitive to this gas (about 0·1 per cent for full-scale deflexion), so that waste removal should not be too difficult.

In the apparatus used, air is passed into the uptakes and ports of the model at measured rates. A small quantity of carbon dioxide from a cylinder is introduced into the gas port line. Samples are taken from the furnace by a probe connected by rubber tubing to the sample tube of the infra-red gas analyser. A small pump provides suction at the outgoing ends of both sample and control tube. The latter draws air continuously from the duct supplying air to the air ports, and a two-way tap enables the sample tube to be connected at will to the gas port supply line. Each of these systems is arranged to be similar in length and speed of aspiration.

At the start of the experiment the sensitivity control of the analyser is adjusted to correspond with the calibration curve provided by the makers[4]. The rate of flow of carbon dioxide is then increased until full-scale deflexion is obtained with the sample taken from the gas port line. This is checked between each reading. The probe is placed in predetermined positions and the readings taken and plotted as contours of equal concentration.

The work, not yet complete, from which the illustrations are taken is designed to supplement that done by the Steelmaking Division of this Association, on the effect of furnace design on gas and air mixing on heat transfer to the hearth[5].

Fig. 1



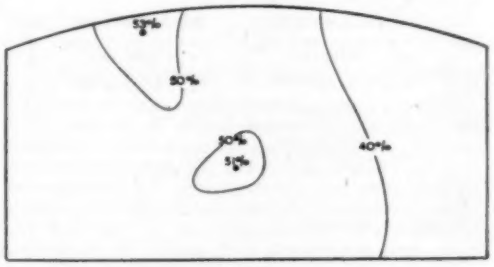


Fig. 2

The accompanying two graphs show the effect of a modification of air port design. Both represent vertical sections across basically similar furnaces at the first charging door. Fig. 1 represents the conventional design, in which points to be noted are the slow mixing shown by the high concentration of unburnt gas, the position of the flame close to the hearth, and the flow of air down the centre of the roof. Fig. 2 shows a rejected modification. Mixing is very good; but the higher concentration near the roof, especially when compared with similar sections near the end wall, indicate that the flame has been blown up to the roof, and this in practice would soon cause the roof to melt. It is to be noted that the asymmetry with respect to the centre line is in agree-

ment with the work of Mr. A. R. Philip[6] in visualizing the flow pattern in open hearth furnaces.

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[2] Rocquet, *C.R. Acad. Sci., Paris*, **208**, 2011 (June 19, 1939).
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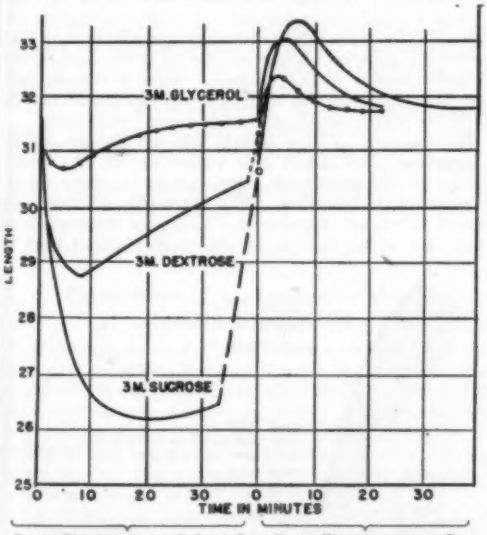
[6] *Nature*, **161**, 479 (1948).

Ionic Exchange and Fibre Contraction

In a communication under the above title, published in *Nature* of May 31, 1947, p. 746, J. L. Mongar and A. Wassermann report some experiments on the de-swelling of calcium alginate fibres in salt solutions. They noted that water-swollen alginate fibres when placed in various alkali-salt solutions first contract and then increase in length. The authors suggest that the contraction results from destruction of calcium ion cross-links between alginate chains as the calcium is replaced by alkali ions. They propose also that plastic flow is mainly responsible for the final swelling effect.

In the course of studies carried out some time ago, we found that water-swollen cellulosic fibres when placed in aqueous salt solutions also contract rapidly at first and then re-swell. The same phenomenon occurs in sugar or glycerol solutions. Some typical observations on water-swollen hydroxyethyl cellulose monofils (0·3 mole hydroxyethyl/glucose unit) are shown in the accompanying graph.

We believe that the contraction is caused by water migrating out of the filament to establish osmotic equilibrium. Eventually, as the solute diffuses into the filament, the osmotic forces are reversed and water flows into the filament, causing an increase in length. It appears to us that the same processes are probably responsible for the shrinking–swelling phenomenon of calcium alginate fibres in salt solutions. If this is true, then considerations of cross-linking and plastic flow are unnecessary.


3M. GLYCEROL
3M. DEXTROSE
3M. SUCROSE
LENGTH
TIME IN MINUTES
De-swelling in sugar and glycerol solutions
Re swelling in water after equilibrium established in sugar and glycerol solutions

De-swelling of hydroxyethyl cellulose monofil (0·3 mole hydroxyethyl/glucose unit). Gel monofil dried, then re wet in water

Flory[1], Hermans[2], and others have developed theories which consider swelling as being an osmotic phenomenon. According to these theories, which appear to be applicable in the present case, swelling is related to the entropy of chain configuration, and equilibrium is established when osmotic entropy and entropy of chain configuration are equal (neglecting heat of mixing). If osmotic entropy is changed by adding a solute to the swelling liquid, the swollen structure will shrink. If a solute diffuses into the swollen structure, osmotic entropy changes and swelling will increase. This can be demonstrated quite simply by allowing a cellulose monofil to come to equilibrium with a sugar solution and then placing it in water, as indicated in the graph. Water migrates in to establish equilibrium with sugar molecules in the swollen cellulose structure, increasing its swelling beyond the water-swollen state. As the sugar molecules diffuse out of the gel, it gradually returns to its original water-swollen dimensions.

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The Potato Caterpillar Pest (*Agrotis* spec.) of Tristan da Cunha

The reports of the Norwegian Scientific Expedition to Tristan da Cunha (1937–38) and of the naval authorities who were stationed on the island during the Second World War have directed attention to the fact that the potato crop, on which the islanders depend so much for food, was seriously affected by the ravage of a caterpillar. Before the departure of the recent expedition sent to the islands by a group of South African fishing interests, it was impossible to find out more about this pest.

As members of this expedition, which left Cape Town on January 29 in the M.V. *Pequena*, it was one of our tasks to study the 'potato grub' problem and to try to find a method of control. We were informed by the Rev. C. P. Lawrence and islanders that the pest had only been noticed since the old custom of using kelp (consisting chiefly of *Macrocystis pyrifera*, Ag., and a small amount of *Ecklonia* sp.) as manure for the potato patches was abandoned and sheep manure used instead. If this observation be accurate, it suggests an interesting line of research, for the kelp would seem to render the soil unsuitable for the development of the caterpillar. In the one month available such a line of research could not be followed, but time did permit the testing of the effects of insecticides on the caterpillars.

We found that only one species of insect was responsible for the damage. Dr. A. J. T. Janse of the University of Pretoria, who was kind enough to examine material of the species, has come to the conclusion that the species is not like any that he knows from Europe or South Africa and, therefore, has not been able to name the species.

Badly defoliated potato plants after having been attacked by the caterpillars. (Photograph by Dr. G. J. Broekhuysen)

The damage done by the caterpillars is very serious, and although we were told that the infestation this season was less than usual, we were none the less impressed by the heavy damage caused. Many patches had been completely defoliated and caterpillars were eating the haulms of the defoliated plants (see photograph). In South Africa this species is not often found on potatoes, nor does it attack the foliage of the various plants on which it occurs; but feeds on the stem at soil-level.

On our arrival in the beginning of February, most of the caterpillars were in the last two instars; but by the time we left a month later, fairly large numbers of very young caterpillars had appeared, indicating a new generation. They chiefly attacked the plants during the night, and on dry days most of them burrowed into the soil at the foot of the plants. On damp days, however, many remained feeding. This habit is well known to the islanders, who send the children in the early morning to pick the caterpillars off the plants and crush them. The caterpillars were not confined to the potato, but were found feeding on a variety of plants, including grasses, thistles, *Rumex* spp., and most vegetables, except pumpkins, tomatoes, strawberries, onions and parsley. Apart from the low settlement plateau with its potato patches, the caterpillars were also found at Cave Point and Sandy Point, both of which are uninhabited. None was found on the high plateau (about 2,000 ft.) or higher up on the mountain.

The effects of three insecticides were tested in cage experiments and two in the field. *Lead arsenate* gave an unsatisfactory average mortality of 35·1 per cent in three sets of cage experiments and is also too dangerous for a backward community such as that on Tristan da Cunha to apply; it was not tried in the field. *Sodium silicofluoride*, given as a bait mixed with bran (1 in 12 by weight), gave an average mortality of 78·2 per cent in five sets of cage experiments and up to 71·6 per cent mortality in three sets of field-tests. In one of the field-tests the concentration of the poison was cut down by half. *Wettable D.D.T.* (50 per cent), in a spray (1 ounce per gallon), gave an average mortality of 88·6 per cent in four cage experiments and 99·1 per cent in three field-tests. Again in the last field-test the concentration of the solution was cut down by half.

Unfortunately, the number of field-tests is rather limited; but they show nevertheless quite distinctly that the pest can be controlled by the use of either D.D.T. spray or sodium silicofluoride–bran bait, or by using them alternately. It will also be advisable to control the pest on the surrounding vegetation, perhaps by the introduction of some insectivorous bird. The local thrush (*Nesocichla eremita eremita*, Gould.), or 'starchy' as the islanders call it, was found to be very fond of the caterpillars. Unfortunately, the large number of rats have nearly exterminated this bird on Tristan. If the rat menace could be checked the thrushes might increase, and in any event their numbers could be augmented from the flocks on the neighbouring islands of Nightingale and Inaccessible.

A full account of the experiments conducted will be submitted for publication to the *Journal of the Entomological Society of Southern Africa*.

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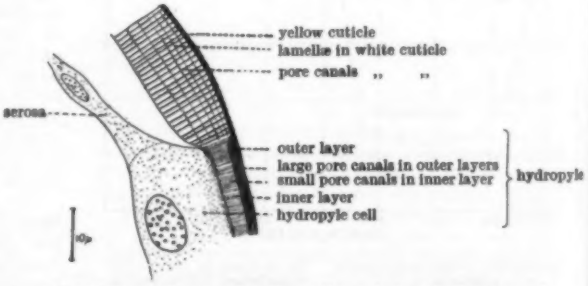
Pore Canals in the Egg Membranes of *Locustana pardalina* Walk.

It has been shown by Slifer[1] that in the egg of *Melanoplus differentialis* water is taken up through a small, circular, specialized area (the hydropyle) in the yellow cuticle. This structure, consisting of two layers, is situated at the posterior tip of the egg and is a secretory product of a group of enlarged serosal cells (hydropyle cells). According to her description, these two layers are continuous with the so-called yellow and white cuticles which cover the remainder of the egg. The outer layer of the hydropyle is several times thicker than the corresponding layer of the unspecialized yellow cuticle and is also distinctly striated. These striations (pore canals) run at right angles to the surface. Slifer also described the inner layer of the hydropyle as being continuous with the white cuticle and of the same structure.

In the egg of the South African brown locust (*Locustana pardalina*) the structure of the outer layers of the hydropyle corresponds in every detail to that of *Melanoplus*. The substance of the inner layer, however, appears to be more homogeneous than the white cuticle of the unspecialized part of



Semi-diagrammatic representation of the posterior tip of the egg of *L. pardalina* showing a small portion of the hydropyle region and adjacent unspecialized yellow and white cuticles

the egg and contains a series of very small pore canals which penetrate this layer at right angles, linking up with the larger pore canals in the outer layer. These small canals are very difficult to demonstrate, but they show up distinctly in paraffin sections slightly overstained in hæmatoxylin. This suggests that they contain cytoplasmic filaments originating in the underlying hydropyle cells. The white cuticle of the remainder of the egg is distinctly laminated, and like the inner layer of the hydropyle it also contains pore canals but of a much larger size.

A detailed account of these and other features of the egg of *Locustana* will appear elsewhere.

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April 9.

[1] Slifer, E. H., *Quart. J. Mic. Sci.*, **3**, 437 (1938).

Control of Intestinal Microflora

IN view of recent work which has directed attention to the importance of the intestinal microflora in nutrition, examinations of the fæces were made on a number of children receiving treatment with streptomycin.

Films showed a fair proportion of Gram-negative bacilli; but in most cases none could be grown. In other cases, streptomycin-resistant strains of *A. ærogenes* were found on culture. In no case could any *B. coli* or Gram-negative bacillus other than *A. ærogenes* be grown.

A strain of smooth *B. coli* was made streptomycin-resistant, and after attempts at inoculation by mouth had failed, rectal inoculation was successful. This has now been carried out on two cases, and in each case the organism appeared in the stools in less than 48 hours; in one case it persisted until treatment was suspended (11 days), and in the other case it is still present at the time of writing (16 days). It is now only just resistant to 10–20 units of streptomycin per ml.

This technique may be useful in assessing the part played by various other species of micro-organisms in nutrition; and also possibly in epidemiological problems.

My thanks are due to Prof. W. F. Gaisford for his ready co-operation, and to my laboratory steward, Mr. H. Ward, for his untiring assistance.

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April 14.

Growth of *Culex molestus* under Sterile Conditions

Aedes ægyptii and *Culex pipiens* are the only two mosquitoes which have hitherto been reared from egg to adult under sterile conditions. It is interesting to note that the autogenous *Culex molestus* can also be bred without difficulty on sterile media.

The following media were found suitable for this purpose (all experiments were carried out at a temperature of 28° C.).

(1) Dried or fresh yeast (autoclaved) 1·2 gm. to 15 ml. distilled water to which 25 eggs of *C. molestus* are added under sterile conditions. On this medium the mosquitoes developed from eggs to adult in 10·5–13 days, but the adults were not viable.

(2) Water plus dried yeast plus the following vitamins: thiamin, riboflavin, pantothenic acid, niacin, pyridoxin, folic acid (each 10 γ per ml.), biotin 0·14 γ per ml. This was the optimum medium, and the development from egg to adult lasted 7·5 days. The mosquitoes were viable. Obviously 1·2 gm. of the best samples of yeast available did not contain sufficient of the above factors to produce viable adults.

(3) Liver extract plus dried yeast (autoclaved) (Trager's medium for *A. ægyptii*). Development from egg to adult lasted 14 days and the adults were viable. Water extract of the same yeast and liver extract allowed development from egg to adult in 20 days; but the adults which emerged were not viable.

(4) Water, glucose (0·1 per cent), a mixture of salts (0·2 per cent), casein hydrolysate (2 per cent) and the above-mentioned vitamin B complex (but with only 7·5 γ biotin per ml.) plus ascorbic acid 150 γ per ml. Although development on this medium was relatively slow (eggs to viable adults in 25 days), it proved to be the most suitable for studying the nutritional requirements of all stages of *Culex molestus*. Thus in the absence of pantothenic acid, all other factors being present, there was no development beyond the first instar; in the absence of thiamin, riboflavin or pyridoxin, the larvæ die in the second instar; in the absence of folic acid the larvæ reach the fourth instar but never pupate. In the absence of niacin the whole developmental cycle lasts 42 days and the adults are viable. In the absence of biotin the cycle lasts 36 days, but the adults are not viable. Ascorbic acid is not essential for complete development of viable mosquitoes, but in its absence the cycle is prolonged to 29 days.

It is interesting to note that the viable females raised on sterile media were autogenous and laid eggs in the absence of any kind of nutrition. Full details will be published elsewhere.

I have to thank Prof. S. Adler for his advice and interest in this work.

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April 1.

Mosquitoes and Malaria

WITH reference to the recent article on the Ronald Ross Jubilee[1], it may be of interest to note that, in a paper read at a meeting of the Royal Scottish Geographical Society in April 1892, Dr. H. Martyn Clark, of Amritsar, remarked "that, as some insects carry the pollen of one plant to the flower of another, so mosquitos [*sic*] transplant the malarial germ to a suitable *nidus* by directly inoculating their victims with it"[2]. He further stated that "it will probably some day be ascertained that the mosquito fulfils a part in their [that is, the germs of malaria] transmission". As Ross met Manson in 1894, and Manson brought forward the mosquito theory in that year, Clark's adumbration seems to be worthy of recall.

J. H. KENNETH

The Scottish Geographical Magazine,
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[1] *Nature*, **162**, 50 (1948).
[2] Clark, H. M., "Remarks on Malaria and Acclimatisation", *Scot. Geog. Mag.*, **9**, 294 (1893).

CHEMISTRY RESEARCH BOARD

A REPORT of the Chemistry Research Board which prefaces the report of the Director of the Chemical Research Laboratory for the year 1946 covers the nine-year period January 1, 1938, to December 31, 1946*, and thus presents a summary of the more important developments since the publication of the second report of the Board, which covered the three years ending December 31, 1937. A fuller account is promised in a further report which is still in preparation.

Both the Board's report and that of the Director devote considerable space to discussion of the post-war plans for the work of the Laboratory. The Chemistry Research Board proposed that the work of the Laboratory should be concentrated on a few well-selected topics in the fields of coal tar, corrosion of metals, inorganic chemistry, high polymers and plastics, organic intermediates and microbiology. For the present, owing to limitations of space, it is proposed that microbiological studies should be concentrated on corrosion problems, and the Board recommends that throughout its work the Laboratory should pay special attention to the development of new techniques. To implement this programme, expenditure at the rate of £70,000 per annum will be required as well as non-recurrent expenditure on equipment estimated at £20,000; these proposals have been approved by the Committee of the Privy Council for Scientific and Industrial Research.

The Director of the Laboratory in his report details the objectives of the work of the five main research sections in which the scientific staff of twenty-five scientific officers, thirty-three experimental officers and assistants, and twenty-five laboratory assistants has been organised to implement these proposals. There are also two non-sectional groups for exploratory and special work under the Director and Assistant Director, respectively. The present objectives comprise the investigation of corrosion in immersed and atmospheric conditions with the view of the prevention of rusting, tarnishing and corrosion of ferrous and non-ferrous metals in industrial use; the investigation of the microbiological corrosion of metals, particularly in soil, by the influence of bacteria which reduce sulphates, and the investigation of *ad hoc* corrosion problems of industrial importance. In the inorganic field they include the investigation of semi-rare metals, especially their isolation from wastes and low-grade sources, the study and development of physical methods of analysis, and development of micro-analytical methods and other new techniques; in that of high polymers and plastics, the determination of the relations between structure and properties and the preparation of improved plastic materials such as glues and ion-exchange resins; and in the coal tar field, the isolation and identification of tar constituents using the newest methods of separation and analysis, determination of the physical and physico-chemical constants of tar constituents and derived or related substances, and the development of new uses for tar products and their derivatives. The programme also includes the study of high-pressure operations and the production of useful chemicals by such means, and the preparation of compounds capable of polymerization or co-polymerization, particularly those containing silicon.

The Board's report, as well as that of the Director, refers to some of the directions in which progress has been made on these main items during 1946, and the latter report describes the new work done by the non-sectional groups in collaboration with the Agricultural Research Council on the formulation of salves or smears for control of ticks and in devising a new micro method for the rapid determination of D.D.T. Satisfactory results have also been obtained by this section in work on blow fly control. In the Engineering Services, the Corrosion Section has redesigned the coupling used for the slow rotation of specimens so as to ensure positive and concentric alignment of the spindles to the shafts, and a sectional view of the arrangement is included in the report. Investigations of the corrosion-rate of mild steel in salt solution using the high-speed rotor suggest that the nature of the surface finish may appreciably influence corrosion-rates and the reproducibility of results.

The Corrosion of Metals Section has continued to develop both the high-speed and the low-speed rotor techniques for immersed conditions, and with the former technique has investigated the influence of surface preparation on the reproducibility of corrosion-rate and the influence of movement on the corrosion-rate of mild steel in fresh water. Using the new endless belt and beaker type of apparatus for accelerated atmospheric corrosion tests recently noted (*Nature*, **162**, 90; 1948) the corrosion of steel in salt water atmospheres and the effect of impact damage on the corrosion of painted steel have been examined. In collaboration with the Light Division of the National Physical Laboratory, a light-reflexion meter, utilizing the integrating sphere principle, has been constructed, and in collaboration with the British Iron and Steel Research Association the corrosion behaviour of a comprehensive series of low alloy steels is being investigated, using the oxygen-absorption apparatus and the low-speed rotor apparatus. An extensive search is being made for organic corrosion inhibitors more efficient than sodium benzoate. Other work has been concerned with wrapping materials and with vapour-phase inhibitors, as well as with the influence various methods of surface treatment have on the corrosion resistance of mild steel and on the protection afforded by applied coatings.

In the Inorganic Section an attempt is being made to correlate the rare metal content of flue dust and coal ash with that of the fuel from which the dust or ash originated; and methods of extraction of germanium and gallium from flue dust are being studied. The physical chemistry group has given attention to detection and possible estimation of some minor metals by fluorescent technique; and in work on foams for fire fighting, carried out for the Ministry of Home Security, a portable foam meter has been designed which has been very useful in large-scale experiments with petrol fires.

The High Polymers and Plastics Section's comprehensive study of the mechanical properties of reinforced plastics, commenced, jointly with the Engineering Division of the National Physical Laboratory, during the War, has led to a clearer understanding of the relationships existing between the mechanical properties of laminated plastics and the properties of their components. In connexion with the study of weathering properties, a more convenient

* Department of Scientific and Industrial Research. Report of the Chemistry Research Board for the Period 1938–1946, with Report of the Director of the Chemical Research Laboratory for the Year 1946. Pp. iv + 68. (London: H.M. Stationery Office, 1948.) 1s. 3d. net.

apparatus is being constructed for the accurate determination of the sorption isotherms of phenol-formaldehyde resins, and the study of the relation between structure and dielectric properties of high polymers is being resumed. A critical review has been made of the literature dealing with the ion-exchange properties of high polymers, and exploratory work commenced on the 'Wofatits'. In the field of adhesives, work has been carried out to improve the setting of resins from monohydric phenols and also of resorcinol-formaldehyde resins. A cold-setting resorcinol-formaldehyde glue S.R.38, developed in 1944–45, has shown excellent strength and durability. A study has also been made of glues for light alloys.

The Coal Tar Section has completed and brought into operation an all-metal semi-scale fractionating column and has used the column in the preparation of a tar-oil fraction containing the two methylnaphthalenes. A high-vacuum pumping system has been set up to manipulate highly purified and hygroscopic materials. A new expression has been deduced for the relationship between differential changes of composition with boiling-point and applied to the quantitative calculations of the changes in composition with temperature of the azeotrope formed between ethyl acetate and ethyl alcohol. Results obtained in the separation of 2 : 6-butidine, β-picoline and γ-picoline by azeotropic distillation with acetic acid are recapitulated in the report, and a method worked out for the separation of crude xylole fractions has been applied to the examination of a number of crudes of different origin. Some work has been done on the fractionation of lutidine bases, and a method of estimating acenaphthylene in acenaphthene based on ultra-violet absorption spectrography has been applied to the determination of the acenaphthylene content of the crude material formed in the dehydrogenation of acenaphthene.

In the Organic Intermediates Section, preliminary work on organic compounds from boron was not promising; the chief attention was therefore given to the organic compounds from silicon, including the direct synthesis of methylchlorosilanes and their separation by fractional distillation and alcoholysis, and the preparation of organo-silica resins and elastomers. Results obtained in the hydrogenation of metallic salts of fatty acids indicate that lead salts may prove superior to those of copper.

The report of the Chemistry Research Board itself refers to many of these investigations, which are described in somewhat greater detail in the Director's report. The former report also mentions the establishment, on the Board's recommendation, of a joint panel on acetylene chemistry, with the Director of the Laboratory as chairman, between the Department of Scientific and Industrial Research and the Ministry of Supply, to consider the present position of the research on and development and production of acetylene in the United Kingdom and its utilization as an intermediate product in chemical industry. The Board has also recommended the resumption of work on the 'Oxo' reaction between olefins, carbon monoxide and hydrogen to yield aldehydes. Reference to the work of the Laboratory during the war years is very brief; but among its contributions to the war effort thus singled out for mention is the rotor test for assessing the relative value of a variety of protective coatings, the evaluation of anti-freeze materials and the discovery of the inhibitive properties of sodium benzoate, both as an addition to aqueous solutions and when incorporated in wrapping materials. A long series of experiments in the Laboratory showed that suitable carbon blacks could be prepared from indigenous material, particularly coal tar products, and a highly successful foam for fighting petrol fires was also developed from indigenous sources. Much attention was given to the development of a food yeast from *Torula utilis* as an insurance against possible shortage of protein food, and on the basis of this war-time research and development, the Colonial Office has now erected a full-scale plant in Jamaica. The shortage of derris led the Laboratory to collaborate with the Agricultural Research Council in the development of products for the control of animal parasites, and a satisfactory D.D.T. emulsion was finally formulated for the control of blow-fly on sheep.

Lists of papers published from the Laboratory during 1946 and of British patents and patent applications granted or filed during the year are appended to the report.

A summary account of current work at the Laboratory was published in *Nature* of July 17, p. 90.

PRODUCTION OF INDOLE BY *ESCHERICHIA COLI*

By Dr. EDWIN A. DAWES

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THE mechanism of the production of indole by *Escherichia coli* has attracted the attention of many workers since Hopkins and Cole[1] first demonstrated that the precursor of indole is tryptophan. The problem is an intriguing one among the bacterial degradation of amino-acids, inasmuch as fission of a carbon–carbon bond occurs at a position in the molecule remote from the amino- and carboxyl-groups, instead of the more usual carbon–nitrogen split. It became even more intriguing when an exhaustive survey of theoretically possible intermediates in the reaction failed to give rise to indole in the presence of the organism.

In 1922, Frieber[2] described a series of growth experiments in which tryptophan in the growth medium was replaced by various indole derivatives, and he found that no indole was produced from 3-indolecarboxylic acid, 2 : 3-indoledicarboxylic acid, skatole, 3-indolealdehyde, 3-indoleacetic acid, β-3-indolepyruvic acid and β-3-indole-ethylamine. In spite of the failure of 3-indoleacetic acid to give rise to indole he postulated that the reaction occurred in two stages, namely: (1) formation of 3-indoleacetic acid; and (2) the breakdown of this compound to indole; only the former occurring in the presence of fermentable carbohydrate.

Harden[3], in 1930, gave the reaction as follows: Tryptophan → β-3-indolepropionic acid → 3-indoleacetic acid → indole.

Extensive work on this subject appeared in 1935 by Woods[4] who, using the washed viable cell suspension technique, demonstrated that five atoms of oxygen are required for the complete oxidation of one molecule of tryptophan, and that *D*-tryptophan is not metabolized; and he presented strong presumptive evidence for the anaerobic production of β-3-indolepropionic acid (cf. Hopkins and Cole[5]). He also investigated the action of cell suspensions of *Esch. coli* on various possible intermediates[6], and he

was forced to reject Harden's hypothesis[5] and also that of Raistrick[7] based on analogy with histidine metabolism. Compounds tried included those used by Frieber[8] and also β-3-indoleacrylic acid, all of which gave no indole production. β-3-Indolepyruvic acid, but only in the presence of ammonia, gave 10 per cent production of indole, presumably due to tryptophan being first formed.

Again in 1935, Happold and Hoyle[9], simultaneously and independently, using non-viable cell suspensions, obtained similar results to Woods with the possible intermediates, and they gave the name 'tryptophanase' to the enzyme complex which is responsible for the reaction. They went on to show that in the presence of fermentable carbohydrate the failure to produce indole is presumably due to the non-production of the tryptophanase system[9]. This observation was afterwards verified by Evans, Handley and Happold[10], in reply to criticism by Fildes[11], and they later showed that complete inhibition of indole production only occurs in the presence of phenylalanine and tyrosine[12].

Meanwhile, Baker and Happold[13] had been concerned with the determination of essential structural conditions necessary for the reaction to occur. By systematically modifying the tryptophan molecule, it was shown that an intact side-chain is necessary for indole production, and (later) that the =NH group of the indole nucleus must be unsubstituted[14]. On the basis of this work, a tentative mechanism for the reaction was suggested involving reductive fission of an intact alanine side-chain.

However, in 1942, Krebs, Hafez and Eggleston[15] suggested that β-*o*-aminophenylacetaldehyde is the effective indole-producing intermediate. They assumed that oxidation of the tryptophan molecule yields β-*o*-aminophenylethanol, which then condenses spontaneously to form indole. This was not substantiated, and the Leeds workers[14] showed that with β-*o*-aminophenylethanol the best results represented only 22 per cent conversion to indole in 18 hours, whereas with tryptophan the yield was 90 per cent in less than 2 hours; furthermore, dimedon completely inhibited the former reaction but was without effect on the tryptophan–indole reaction.

The next hypothesis concerning the mechanism of the reaction was put forward by Tatum and Bonner[16] in 1944. From a study of the way in which a mutant strain of the mould *Neurospora crassa* synthesizes tryptophan from indole and serine, they postulated that the breakdown of tryptophan to indole by *Esch. coli* is a reversal of this reaction, that is, hydrolytic fission to yield indole and serine. In support of this, experiments were quoted in which inhibition of indole production is produced by the addition of serine to tryptophan in the presence of sterile washed suspensions of the organism, the effect being specific and a function of the concentration; the biosynthesis of tryptophan from indole and serine was also claimed. The biosynthesis of tryptophan by *Esch. coli* was not verified by Fildes[17] or the present author.

Since all the 3-indolyl derivatives tried failed to give rise to indole, the hypotheses of Baker and Happold[13] and Tatum and Bonner[16] involving fission of the intact side-chain, as alanine and serine respectively, were eminently attractive. Dawes, Dawson and Happold[18] conducted an analytical investigation of the reaction employing paper chromatography, and making use of Dawson's[19] observations of the effect of 'Mepacrine' on the tryptophanase activity of *Esch. coli*. Dawson showed that under the influence of 'Mepacrine' there is no oxygen uptake by washed cells over an initial 60 minutes while indole is produced in reduced amount. The possibility of oxidation of any intermediate in these circumstances is much reduced, and under such conditions alanine was detected whereas serine was never found, thus strengthening Baker and Happold's hypothesis. Attempts to produce alanine by chemical reductive fission of tryptophan using Raney nickel catalyst failed, although indole was produced. This may not be due to true reductive fission but rather the catalytic effect of a heavy metal on tryptophan, as in Herzfeld's[20] experiments, and more recently in the work of Kuiken, Lyman and Hale[21].

The inhibitory action of serine on indole formation was shown to depend on the degree of saturation of tryptophanase with tryptophan, and to be not simply a function of concentration; while the possibility of a phosphoclastic fission occurring to yield indole and serinephosphoric acid was examined by paper chromatography and rejected.

Dawes, Dawson and Happold[22] obtained the enzyme in the cell-free state and investigated the action of various recognized inhibitors[23,24] on it. In this way evidence was obtained for the presence of carbonyl and iron-containing components, while spectrophotometric analysis furnished evidence of a nicotinamide system; iron was detected by spectrochemical analysis. The enzyme could be resolved by dialysis, and riboflavin was shown to be present in both apoenzyme and dialysate by microbiological assay. Reactivation of the apoenzyme was achieved with pyridoxal phosphate, riboflavin and diphosphopyridine nucleotide. Crude enzyme extracts performed the reaction with consumption of five atoms of oxygen, but the partially purified enzyme produced indole anaerobically as recorded by Wood *et al.*[25]. Such samples required only pyridoxal phosphate as coenzyme, and hence riboflavin and diphosphopyridine nucleotide appear to be concerned in the further oxidation of the pyruvic acid first formed; purification removes the enzyme(s) concerned in this.

However, that alanine is not the normal intermediate in indole production was shown by Wood, Gunsalus and Umbreit[25], who partially purified the enzyme by ammonium sulphate fractionation and found that it was then resolved and could be reactivated by pyridoxal phosphate. This enzyme would not deaminate alanine or serine, while still producing indole from tryptophan, and hence neither could be intermediates in the reaction; the products of the reaction are one mole each of indole, pyruvic acid and ammonia, and no oxygen is taken up in the process.

It seems a pity that Wood *et al.* call the enzyme which effects the fission 'tryptophanase', when this term was originally used to connote the complex performing the complete oxidation. An iron-containing system appears to function in the overall oxidation reaction, and it is significant that verdoperoxidase and cytochrome *c* both stimulate indole production.

The Michaelis constant of tryptophanase is given as $2\cdot5 \times 10^{-3}$ by Wood *et al.*, but they state that the half maximum reaction-rate is obtained with 35 μgm. tryptophan per ml. and this gives a K_M value of $1\cdot7 \times 10^{-4}$ and is more in accord with the author's figure of $4\cdot1 \times 10^{-4}$.

The fact that indole is formed anaerobically raises interesting speculation on the claims of Hopkins and Cole and Woods that β-3-indolepropionic acid is produced in anaerobic culture; strain differences may well account for this. However, the search for inter-

mediates in the reaction has now been cleared up by Wood *et al.*, although α-aminoacrylic acid may be the primary fission product (this would decompose spontaneously to pyruvic acid and ammonia in aqueous medium), and the reaction is a balanced one from the oxido-reduction point of view. The detection of alanine in the presence of 'Mepacrine' may be due to a diversion of the normal reaction path, such as hydrogenation of α-aminoacrylic acid, or to reamination of the pyruvic acid product.

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EXCITATION PROCESSES IN MOLECULAR NITROGEN

By R. W. NICHOLLS

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IN controlled electron experiments it has been usually assumed[1] that in the emission of the triplet bands of molecular nitrogen, transitions to the upper levels of the band systems concerned come about directly as a result of collisions of the first kind between molecules in the ground-state $X^1\Sigma_g^+$ and fast electrons. A further assumption made is that the energy values of the upper states of the bands concerned are the voltages at which they respectively appear when excited by an electron beam of controlled energy. These assumptions lead to the placing of the triplet-levels approximately 2 volts higher than the normally accepted values based on reliable spectroscopic evidence[2]. In particular, the $A^3\Sigma_u^+$-level would be placed about 2 volts above the value suggested by the analysis of the Vegard – Kaplan bands $A^3\Sigma_u^+ \rightarrow X^1\Sigma_g^+$.

The results of these experiments[1], which are reasonably consistent, are summarized in the table on p. 232. It would seem, therefore, that the assumptions mentioned are in error. This view is further strengthened by the following facts.

(1) Only singlet systems are obtained in absorption experiments in nitrogen, namely, the Lyman – Birge – Hopfield and Birge – Hopfield bands. The triplet bands do not appear in absorption, and consequently as electron and photon collisions with molecules generally result in the same excitation, it would be expected that electron collisions with ground-state molecules would excite the singlet- rather than the triplet-levels.

(2) The multiplicity change (singlet-triplet) involved in direct excitation of the triplet-levels from the singlet ground-state makes such a transition forbidden, and therefore a relatively rare event, both in the case of electron collisions and of photon collisions.

It is the purpose of this note to suggest a more probable excitation process which accounts for the observed experimental results without incurring an artificial raising of the triplet-levels, and which violates neither the selection rules nor the Franck – Condon principle.

It is suggested that primary excitation by collisions between ground-state molecules and electrons results in the population of the singlet-levels: $a^1\Pi$ and b. b^1 is a group of eight levels between 12·5 and 14 volts (the upper states of the Birge – Hopfield and Gaydon bands), which for the purposes of this discussion may be considered together. By analogy with the atomic case[4], we expect the excitation probability function of a level for non-intercombination (singlet-singlet) transitions to rise from zero at the energy of the level in question to a broad maximum somewhat above it. A singlet-level will therefore be most populated when the exciting electrons have the energy corresponding to this maximum. Population of the triplet-levels can then come about by intercombination collisions of the second kind between slow electrons and the molecules in the excited singlet-states. For such second-kind collisions to be effective, two considerations have to be taken into account: (1) The balance between the life-time of a molecule in an excited state and the collision frequency of slow electrons. This is governed by excitation conditions and depends greatly on pressure. (2) The balance between the transition probability and the probability that, on collisions between an excited molecule and a slow electron, intercombination transitions of the second kind will occur. This is governed by molecular constants only.

An analysis which has been made of the excitation kinetics of this mechanism shows it to be more likely than the one previously assumed. Details of this analysis will be published shortly.

This mechanism was suggested primarily by a comparison of the energies of the singlet-levels with the electron energies at which the triplet bands appeared (see table). The appearance potential of the first positive bands, *after correction by extrapolation to the* (0,0) *band*, is approximately 9·5 volts, which is about the value for the maximum excitation probability of the $a^1\Pi$-level. The appearance potential of the second positive bands is approximately 13 volts, which again is very near the maximum probability of excitation of the b-levels. The fact that the first positive appears at approximately 9·5 volts on the excitation of the $a^1\Pi$-level, and that it is not fully developed until the second positive bands appear at approximately 13 volts, reaching a maximum with

	Energy-levels			Band systems	Appearance potentials (volts)	Remarks
	Singlets	Energy (volts)	Triplets			
	$X^1\Sigma_g^+$ (ground-state)	0		$A^3\Sigma_u^+ \rightarrow X^1\Sigma_g^+$ Vegard – Kaplan		Forbidden transition
		6·2	$A^3\Sigma_u^+$			
		7·3	$B^3\Pi_g$	$B^3\Pi_g \rightarrow A^3\Sigma_u^+$ First positive	9·3 (S), 9·4 (V), 9·5 (D)	Fully developed on excitation of second positive, maximum intensity at ~15 volts
N_2	$a^1\Pi_g$	8·5				
		11	$C\,^3\Pi_u$	$C^3\Pi_u \rightarrow B^3\Pi_g$ Second positive	12 (D), 13 (S), 13·16 (T, W), 13·4 (V)	Maximum intensity at ~15 volts
		12·8	$D^3\Sigma_u^+$	$D^3\Sigma_u^+ \rightarrow B^3\Pi_g$ Fourth positive	15 (D)	Maximum intensity at ~20 volts
	b (8 levels)	12·5 – 14				
	Doublets					
N_2^+	$X^{\prime 2}\Sigma_g^+$	15·6		$B^{\prime 2}\Sigma_u^+ \rightarrow X^{\prime 2}\Sigma_g^+$ First negative	18 (D), 19 (S)	Maximum intensity at ~80 volts
	$B^{\prime 2}\Sigma_u^+$	18·7				

(S), Sponer; (D), Duncan; (T, W), Thompson and Williams; (V), Vegard.

them, strongly suggests that the primary population of the B^3 -vibrational-levels, below the $a^1\Pi$-level, is due to collisions of the second kind between slow electrons and molecules in the $a^1\Pi_g$-state, while the secondary population of the $B^3\Pi$-levels, especially those which lie above the $a^1\Pi_g$-level, results from the emission of the second positive bands $C^3\Pi \rightarrow B^3\Pi_g$. A further factor contributing to the population of the $B^3\Pi$-levels, when b is excited, would be collisions of the second kind between slow electrons and molecules in the b-state. The fourth positive system $D^3\Sigma \rightarrow B^3\Pi$ appears at 15 volts when certain of the b-levels which lie above the $D^3\Sigma$-level become populated, and reaches a maximum intensity at approximately 20 volts. Owing to the metastability of the $A^3\Sigma$-level, numerous collisions of the second kind with slow electrons will be probable. A radiationless $A^3\Sigma \rightarrow X^1\Sigma$ transition will therefore be more likely than the emission of the Vegard – Kaplan bands in most usual forms of discharge in nitrogen. The first negative system $B'^2\Sigma \rightarrow X'^2\Sigma$ of N_2^+ will be excited directly by first-kind collision between ground-state $X^1\Sigma$ N_2 molecules and fast electrons.

The mechanism thus adequately accounts for the observed excitation potentials in terms of known levels of nitrogen. Further facts in its favour are:

(1) It is in accordance with the Franck – Condon principle in initial excitation.

(2) There is no change in multiplicity in the initial excitation.

(3) The recently proposed g symmetry of the $a^1\Pi$-level[6] renders that level metastable, thus raising the excitation life-time and making collisions of the second kind even more probable. Although the metastability tends to make the initial excitation less probable, the fact that the singlet bands appear in absorption shows that it can, and does, occur with a greater probability than the singlet-triplet excitation. The long path-length required for this absorption to occur provides experimental evidence for the metastability, as was pointed out by Herzberg[5].

The above ideas are a result of work attempting to correlate spectroscopic and electrical observations on a glow discharge in nitrogen. Should the suggested mechanism prove to be correct, it may have an important bearing on auroral excitation, since many current theories of the aurora include direct singlet-triplet excitation of neutral nitrogen, N_2, by electrons.

I should like to express my grateful thanks to Dr. R. W. B. Pearse for valuable discussions on this subject.

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INTERNATIONAL GEOLOGICAL CONGRESS

PREPARATIONS are now well advanced for the Eighteenth Session of the International Geological Congress. So far about 1,500 geologists, representing some sixty countries, have registered as members. The programme of long excursions associated with the Congress begins on August 7.

The Session will be formally inaugurated at a meeting of the General Assembly in the Royal Albert Hall on August 25, when Mr. Herbert Morrison will welcome the delegates and members on behalf of the British Government, and Sir John Anderson, honorary president of the General Organising Committee, will speak on behalf of that Committee. Prof. H. H. Read, president of the Geological Society of London, is president-designate of the Session.

During the following days there will be an extensive series of sectional meetings, at which about two hundred and fifty papers, of which only a few can be mentioned in this notice, and covering a very wide range of topics, are due to be presented.

In the Section on Problems of Geochemistry, questions connected with the development and migration of magmas and the genesis of ore deposits, the geochemical history of single elements, and the origin of serpentines will be discussed by distinguished contributors, including Dr. N. L. Bowen of Washington, Prof. H. von Eckermann of Stockholm, Prof. P. Niggli of Zurich and Prof. W. Wahl of Helsingfors. In another petrological section, devoted to "Metasomatic Processes in Metamorphism", the 'magmatists' and the 'transformists' will present contrasting views on the respective importance of magmatic and hydrothermal penetration and of solid diffusion in the process of granitization and of metamorphism in general. The contributors include Prof. P. Eskola of Finland, Prof. N. H. Magnusson of Stockholm, Prof. E. Wegmann of Neuchatel, Prof. H. G. Backlund of Uppsala, and Prof. Ian Campbell of California.

Stratigraphical and palæontological problems will be discussed by several sections. The Section on Rhythm in Sedimentation will include papers by Prof. R. C. Moore, Dr. H. R. Wanless, and other American authors on cyclic sedimentation in the Palæozoic Rocks of the United States, and by Prof. G. F. Troedsson of Stockholm and other authors on rhythm in the Mesozoic and Tertiary sediments of Europe. Prof. A. Renier of Brussels, Dr. S. J. Dijkstra of Heerlen, Prof. Y. C. Sun of Peiping, Dr. J. J. Gorsky of Leningrad, and Dr. F. K. G. Mullereid of Mexico City are among contributors who will deal with general and regional problems of facies correlation in the Section on Faunal and Floral Facies and Zonal Correlation. The correlation of continental vertebrate-bearing rocks will be discussed in a separate section, and the overseas contributors include Dr. C. Teixeira of Lisbon, Mlle. M. Richard of Algiers, Dr. R. A. Stirton of California and Prof. Erik Stensiö of Stockholm. This Section will also hold a joint meeting with the Section on the Pliocene–Pleistocene Boundary. The latter will attempt to reach an agreed definition of the lower limit of the Pleistocene System by synthesis of the views of specialist contributors, including Dr. L. S. B. Leakey of Kenya, Dr. A. Halicka of Warsaw, Dr. D. N. Wadia of India, Prof. van der Vlerk of Leyden, Prof. C. Migliorini of Florence and Prof. C. Arambourg of Paris. Another section will discuss the relation between earth movements and organic evolution, and includes papers by Drs. K. Zapletal and L. V. Čepek of Czechoslovakia, Academician V. A. Obruchev of Moscow, and Dr. A. Chavan of Nanterre.

An interesting field of inquiry is covered by the Section on the Geology of Sea and Ocean Floors. In this a number of American geologists will describe recent work on submarine geology of the Northern Marshalls, including recent borings on Bikini Atoll; and Prof. C. Francis-Bœuf of Paris will speak of the use of the 'Bathyscaphe-Piccard-Cosyns' in submarine studies. Other contributors are Prof. R. M. Field of Princeton, Prof. P. H. Kuenen of Groningen, and Dr. J. S. Lee of Nanking.

Three sections are specifically devoted to applied geology. A symposium on the geology, paragenesis and reserves of the ores of lead and zinc has been prepared under the editorship of Dr. K. C. Dunham and will be discussed by a special section. Its assessment of world reserves suggests that little more than about nineteen years production of lead ores and twenty-four years production of zinc ores can be foreseen. The Section on the Geological Results of Applied Geophysics will deal with recent magnetic, electrical, gravitational and seismic work on diverse problems in many countries. The Section on the Geology of Petroleum will include a wide range of papers on general and regional subjects, among which recent work in the oilfields of the Middle East is prominent.

There is also a section in which a great variety of miscellaneous papers will be presented. Among these, tectonic studies predominate, and the authors include Prof. A. Noe-Nygaard of Copenhagen, Prof. O. Holtedahl of Oslo, Prof. A. Demay of Paris, and Dr. A. Heim of Zurich.

The Association des Services Géologiques Africains will hold a series of open meetings at which a synthesis of research on African geology during the last decade will be attempted, and problems of correlation within the African continent will be discussed. The International Palæontological Union will also hold open meetings, including one specially devoted to the stratigraphical use of Foraminifera and another to the nomenclature of fossils. A series of special meetings on the mineralogy and geology of clays has been organised in conjunction with the Clay Minerals Group of the Mineralogical Society.

Three major items in the technical programme are special addresses on the structural history of Britain, by Sir Edward Bailey and Prof. O. T. Jones, who will respectively deal with Scotland and with England and Wales; and a colour film and lecture on the new Mexican volcano Paricutin, presented by Dr. F. H. Pough of the American Museum of Natural History.

During the period of the Session receptions will be given by H.M. Government, by the Geological Society of London, the University of London and a number of other authorities and institutions.

A series of ninety-six day and half-day excursions demonstrating the geology of south-eastern England will take place during the period August 20–September 4. After the closing meeting of the General Assembly on September 1, there will also be another series of seventeen long excursions covering practically the whole of Great Britain and Eastern Ireland.

CONDENSATION OF INTERSTELLAR MATERIAL INTO STARS

F. HOYLE has suggested (*Mon. Not. Roy. Astro. Soc.*, **107**, 4; 1948) a criterion for determining the degree of condensation of interstellar material into stars. Observational data for disk-shaped nebulæ, such as *M* 31 and *M* 33, suggest that only a small fraction of the total mass is in the form of stars, whereas Oort has found that the elliptical nebula NGC 3115 must be almost entirely composed of stars. The paper is devoted to a consideration of the factors that determine the fraction by mass of a nebula that is condensed into stars, and a new method for attacking this problem is developed which suggests that condensing stars with masses exceeding 0·2 that of the sun must become rotationally unstable before reaching the main sequence stage, and such stars must evolve by ejecting material

until their masses are reduced below the critical value. Present available information suggests that the ejected material is thrown off to infinity, and hence stars forming in the main body of nebulæ such as *M* 31 or *M* 33 have masses less than 0·2 that of the sun at the time of condensation to the main series state; but the masses can afterwards increase by accretion of interstellar matter. The application of the criterion shows that we should expect both the nuclei of disk-shaped nebulæ and the elliptical nebulæ to be almost entirely condensed, but the main body of a disk-shaped nebula such as *M* 31 would be largely uncondensed. The highly condensed state of the nuclei of disk-shaped nebulæ and elliptical nebulæ receives an important application in determining the ages of the extragalactic nebulæ, and Hoyle shows that these are of the order 5×10^9 years.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PLANT PATHOLOGIST (Scientific Officer Grade), and a FIELD OFFICER (Experimental Officer Grade), in connexion with potato storage investigations at the University of Nottingham, Sutton Bonington—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W.1 (August 14).

CHARLES BROTHERTON SCHOLARSHIP and UNITED KINGDOM GAS CORPORATION SCHOLARSHIPS in the Department of Coal Gas and Fuel Industries with Metallurgy—The Registrar, The University, Leeds 2 (August 14).

TECHNICAL ASSISTANT (Grade B) IN THE BOTANY DEPARTMENT, chiefly for mycological work—The Secretary and Registrar, University College of North Wales, Bangor (August 14).

ASSISTANT LECTURER (Grade III) IN GEOLOGY—The Secretary, The University, Edmund Street, Birmingham 3 (August 14).

RESEARCH FELLOW to lead a research group engaged on work connected with the chemical constitution of coal, and two RESEARCH WORKERS—The Secretary, The University, Birmingham 3 (August 15).

LECTURERS IN (*a*) PHYSICS, with subsidiary Mathematics, (*b*) ELECTRICAL AND MECHANICAL ENGINEERING, in the Ministry of Supply School of Electronics, Malvern—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs. (August 16).

LECTURER IN CIVIL ENGINEERING—The Registrar, The University, Leeds 2 (August 16).

LECTURER IN THE DEPARTMENT OF GEOLOGY with special qualifications in Mineralogy and Petrology—The Registrar, The University, Manchester 13 (August 20).

PRINCIPAL SCIENTIFIC OFFICER to lead a team engaged in experimental and design work, involving problems of pilot plant for chemical engineering, heat transfer and development of special instrumentation and remote control methods, and SENIOR SCIENTIFIC OFFICERS for experimental and design work, involving similar problems, in the Engineering Division of the Atomic Energy Research Establishment, Harwell, Berks, under the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W., quoting No. 2205 (August 26).

LECTURER (Grade IIc or IIb) IN THE DEPARTMENT OF CHEMICAL ENGINEERING—The Secretary, The University, Edmund Street, Birmingham 3 (August 30).

LECTURER IN PSYCHOLOGY in the University of Sydney—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W. 1 (August 31).

DEMONSTRATORS IN BIOLOGY AND CHEMISTRY—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (August 31).

PHYSICIST TO THE DEPARTMENT OF RADIOTHERAPY—The Superintendent, Guy's Hospital, London, S.E.1 (August 31).

SENIOR ORGANIC CHEMIST in the Biochemistry Section for work on the organic constituents of fruit-bearing plants—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (August 31).

LECTURER IN MATHEMATICS—The Registrar, University College, Southampton (September 4).

LECTURER or ASSISTANT LECTURER IN MATHEMATICS, with special qualifications in Applied Mathematics—The Registrar, University College of Wales, Aberystwyth (September 4).

TUTORIAL STUDENTSHIPS IN ELECTRICAL ENGINEERING, and ORGANIC CHEMISTRY IN THE DEPARTMENT OF PHYSIOLOGY—The Registrar, King's College, Strand, London, W.C.2 (September 13).

DIRECTOR OF MUSEUMS—The Town Clerk, City Chambers, Glasgow, W.2 (September 15).

PROFESSOR OF CIVIL ENGINEERING in Natal University College—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (September 15).

MULLARD READERSHIP IN ELECTRONICS at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 15).

LECTURER IN GRAPHICS AND MACHINE DRAWING, a LECTURER IN ENTOMOLOGY, a SENIOR LECTURER IN ORGANIC CHEMISTRY, and a SENIOR LECTURER IN INORGANIC CHEMISTRY—The Registrar, Rhodes University College, Grahamstown, South Africa (September 15).

SENIOR LECTURER IN THE DEPARTMENT OF BOTANY—The Registrar, The University, Manchester 13 (September 17).

READERSHIP IN MATHEMATICS at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 22).

READERSHIP IN CIVIL ENGINEERING at King's College, Strand—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 1).

ECONOMIC BOTANIST IN THE DEPARTMENT OF AGRICULTURE, British Guiana, to take charge of the Central Rice Station—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

TECHNICIAN IN CHEMISTRY DEPARTMENT—The College of the Pharmaceutical Society, 17 Bloomsbury Square, London, W.C.1.

ECOLOGIST IN THE TSETSE CONTROL DEPARTMENT, Government of Uganda—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

CONTROLLER OF AGRICULTURE IN CYRENAICA—The War Office, C.4(E), Room 447, Metropole Buildings, Northumberland Avenue, London, W.C.2.

ENTOMOLOGISTS for advisory and research work on crop pests and special research on the sisal weevil, on the staff of the Government of Tanganyika—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

LIGHTING ENGINEERS, HEATING and VENTILATION ENGINEERS, and TECHNICAL RESEARCH OFFICERS, in the Factory Standards and Design Branch of the Australian Department of Labour and National Service—Mr. T. C. Graham, Australia House, Strand, London, W.C.2.

GAME RANGER in Tanganyika, and a GAME WARDEN in the Gold Coast—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

HEAD OF THE COLLEGE—The Clerk, National College of Rubber Technology, Northern Polytechnic, Holloway Road, London, N.7.

CHIEF COMPUTOR IN THE SURVEY DEPARTMENT, Nigeria—The Director of Recruitment, Colonial Service, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

LECTURER IN MATHEMATICS in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2.

SENIOR LABORATORY STEWARD (chemistry and biology)—The Bursar, Merchant Taylors' School, Sandy Lodge, Northwood, Middx.

RESEARCH ASSISTANTS (2, men or women) in the Department of Chemistry for work in physical-organic chemistry—The Professor of Chemistry, Royal Holloway College, Englefield Green, Surrey.

LECTURER or an ASSISTANT LECTURER IN GEOLOGY—The Registrar, The University, Nottingham.

ASSISTANT MANAGER of the acid and ammonia works at Phoenix Wharf, East Greenwich—The Secretary, South Metropolitan Gas Co., 709 Old Kent Road, London, S.E.5, endorsed 'Assistant Manager—Chemical Works'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

An Index to Modern Remedies. By William Mair. Fourth Series. Pp. 68. (Glasgow: The *Scottish Chemist*, 1948.) 3*s*. [245

Scottish Council (Development and Industry). Report of the Committee on the Chemical Industry of Scotland. Pp. 39. (Edinburgh: Scottish Council, 1948.) 2*s*. [255

The Training of a Doctor. Report of the Medical Curriculum Committee of the British Medical Association. Pp. 152. (London: Butterworth and Co. (Publishers), Ltd., 1948.) 7*s*. 6*d*. net. [255

Ministry of Fuel and Power. Fuel and the Future: Proceedings of a Conference held in London on October 8th–10th, 1946, under the auspices of the Fuel Efficiency Committee. Vol. 1. Pp. vi+370. 6*s*. net. Vol. 2. Pp. vi+374. 6*s*. net. Vol. 3. Pp. vi+211. 3*s*. 6*d*. net. (London: H.M. Stationery Office, 1948.) [255

Standard Valves. Pp. 328. (London: Standard Telephones and Cables, Ltd., 1947.) 15*s*. [255

Commonwealth Bureau of Soil Science. Technical Communication No. 44: The Spectrographic Analysis of Soils, Plants and related Materials. By R. L. Mitchell. Pp. v+183. (Aberystwyth: Commonwealth Agricultural Bureaux, 1948.) 12*s*. 6*d*. [275

The Protection of Workers from Radiation Hazards in Atomic Energy Plants and other Establishments using Radioactive Substances. Prepared by the Atomic Sciences Committee, Association of Scientific Workers. Pp. 24. (London: Labour Research Department, 1948.) 1*s*. [275

Other Countries

Science and Public Policy. Vol. 1: A Program for the Nation. A Report to the President by John R. Steelman. Pp. x+73. 20 cents. Vol. 2: The Federal Research Program. A Report to the President by John R. Steelman. Pp. viii+318. 55 cents. Vol. 3: Administration and Research. A Report to the President by John R. Steelman. Pp. viii+324. 55 cents. Vol. 4: Manpower for Research. A Report to the President by John R. Steelman. Pp. viii+166. 35 cents. Vol. 5: The Nation's Medical Research. A Report to the President by John R. Steelman. Pp. x+118. 25 cents. (Washington, D.C.: Government Printing Office, 1947.) [275

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Nauka Polska: jej Potrzeby, Organizacja i Rozwój (Science and Letters in Poland: their Needs, Organization and Progress). Tom 25. Pp. x+590. (Warszawa: Kasy Imienia Mianowskiego, 1947.) [36

East Africa High Commission. Paper No. 1: Fauna of British Eastern and Central Africa. (Proceedings of a Conference held in Nairobi on 8th and 9th May, 1947.) Pp. 74. (Nairobi: Government Printer, 1948.) 2*s*. 6*d*. [36

Physiologia Comparata et Oecologia: an International Journal of Comparative Physiology and Ecology. (Quarterly.) Vol. 1, No. 1, April 15, 1948. Pp. 64. (Den Haag: Dr. W. Junk, 1948.) 36 fl. per Vol. [36